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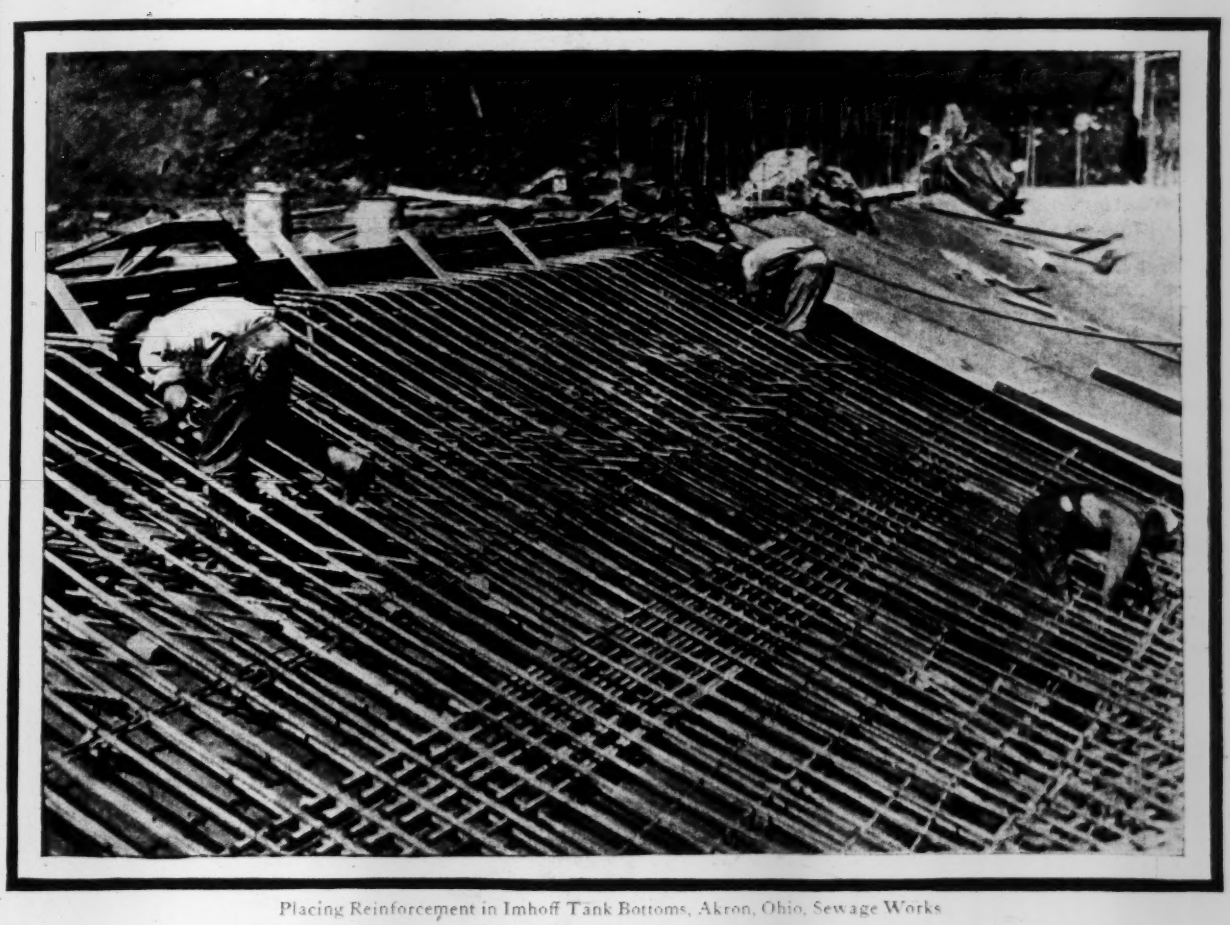

Placing Reinforcement in Imhoff Tank Bottoms, Akron, Ohio, Sewage Works

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Rainfall in the New England Flood

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DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

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Annihilating Space

IN THE course of the ordinary day's news it was recorded last Saturday that our modern Columbus, Colonel Lindbergh, had on that day traveled from Detroit to New York in his airplane in something less than three hours, making the journey at a sustained speed of nearly 200 miles per hour. Our twentieth-century progress is playing havoc with space. Mankind seems to be progressing rapidly on the road toward the ultimate annihilation of distance—an end which, like the mathematician's limits, must ever remain beyond complete attainment, though it may be approached almost indefinitely. There appears to be constant acceleration of the rate at which science and technology advance, and doubtless we must look for future surprises even greater than those of the recent past. Only yesterday we marveled at the wonder of overnight transmission of letters between New York and Chicago, and now Detroit has been shifted eastward to the longitude of Scranton. The art of transportation is in a period of evolution.

The Engineer's Celebration

CEREMONIES of unique character last Saturday opened that unique and ultra-modern work of the civil engineer's art, the Holland Tunnel, the great twin vehicle tunnel under the Hudson between New York and Jersey City. High political officials were there, chief among them the two governors, Alfred Smith of New York and Harry Moore of New Jersey, who remarked with what seemed to be genuine feeling on the closer union of the two states which will result from the opening of the tunnel. President Coolidge was there in effect, for his pressing a button at Washington gave the signal for the formal opening of the tunnel. There were also tunnel commissioners, and senators, and clergymen who pronounced blessings on the completed enterprise. But—the unprecedented feature—the engineer of the work was also on the rostrum, and was asked to speak. Moreover, his words were listened to with keener attention almost than those of Governor Smith, and with a significant gesture of respect on the part of the audience, which rose to hear him as it did for the clerical invocations and the singing of the national anthem. Perhaps this was due in part to the tributes which nearly all of the speakers had paid the memory of Clifford Holland, the young genius who shaped the plan and drove it through, and of Milton Freeman, who for a year carried the burden which Holland relinquished at his untimely death. But there was more than this in the attitude of the people who witnessed the ceremonial opening. They seemed plainly to express their recognition of the fact that here was a work of outstanding greatness, an achievement which mere money, mere political craft, could not achieve; which was made possible only by the engineer's masterly art; and for which the engineer deserved to be honored—for himself, for his fellow-workers, and for those who have departed and whose names are perpetuated by the tunnel itself—the Holland Tunnel—and by the New York approach plaza—Freeman Square. Perhaps the action of the assembly was a mere gesture. Yet even as a gesture it was a significant token of the engineer's higher place in the community's esteem today.

Traffic Marvels

WITH the stroke of midnight Saturday, or a minute or so thereafter, regular toll traffic through the Holland Tunnel began. And quite in agreement with forecasts, the roadways in both directions were filled to a capacity with trucks and passenger vehicles crossing eastward or westward. Therewith the incomprehensible traffic marvel of this modern era once more forced itself upon notice. Here was a new facility provided at a cost of fifty millions, just completed, and on the instant filled with an endless caravan of men and things that had not existed a few hours before. By virtue of this press of traffic the new tunnel will increase the resources of the cities which it serves by far more than its cost; and yet at the very moment of its completion it demonstrated that added traffic facilities are needed. During the inaugural speeches, in fact, Governor Smith referred to the evident need for more highways across the river, and predicted that the interstate agency of the Port Authority will provide them. One additional crossing is already under construction—the Fort Lee bridge—and there is no room to doubt that it too will be in full demand from the day of its opening. Evidence of the vital necessity for more complete integration of regions separated by physical barriers is so clear and yet so surprisingly new a development, that for the present we can do no more than express wonder at the magnitude of the movements into which modern life habits are leading. That this tremendous traffic growth and the instruments which we construct to serve it mean a vast increase in the efficiency of mankind can hardly be questioned. Recent financial history indicates that we are correctly realizing this higher efficiency. How we will succeed in putting it to good account must be left for the future to answer.

East Bay Cities Vote

UNLIKE San Francisco, Oakland and the eight other cities composing the East Bay Municipal Utility District have voted for water mains to distribute water from the supply system now being constructed at public expense. Presumably, San Francisco will do the same before its Hetch Hetchy aqueduct is completed. Three times a majority, but not the required two-thirds, of votes has been cast at San Francisco to buy out the Spring Valley Water Co. The popularity of full municipal ownership in the East Bay District is indicated by the 8 to 1 vote cast on Nov. 1. In some of the cities the ratio was much higher, as shown in *Engineering News-Record*, Nov. 10, p. 774. When San Francisco and the

nine East Bay cities have full municipal ownership of their water-works the small percentage of urban population now supplied by private water companies will be made still smaller.

Swords and Plowshares

AN ANNOUNCEMENT issued by the War Department last week states that the army engineers are about to begin a study of the New England flood. The news is surprising, for flood study has heretofore not been the function of the Corps, whereas the subject has been the concern of a number of other governmental agencies: the Geological Survey, the Department of Agriculture, the Weather Bureau and the Bureau of Reclamation, each of which has acquired qualifications for rainfall and runoff studies not possessed by the army engineers. If these civilian agencies of the government are to be left unutilized in the present need, and their proper work turned over to the already overworked army engineers, the step is regrettable. We yield to none in our respect for the ability and integrity of the Corps of Engineers. But we have serious misgivings about the progressive attempts at transforming the Corps into the general public-works engineering arm of the federal government. Such a transformation is compatible with the interests of neither the military nor the civil engineering service. Beating swords into plowshares is praiseworthy only if they cease to be swords; else the plowing will be ill done.

A Noteworthy Tunnel Contract

A NOTABLE contract for tunnel construction in British Columbia is outlined in the unit prices pages of this week's construction news. On a two-mile water power tunnel to cost a million and a quarter, there was, with nine bidders, a spread between low and high bids of only 34 per cent. Compared with the Argentine tunnel work noted in our issue of Sept. 29, where the spread between low bid and the next lowest was 54 per cent and that between low bid and high bid was over 100 per cent, this closeness of contract estimating appears almost marvelous. The more significant feature of the Canadian contract, however, is that the owner, an electric railway company, elects to furnish delivered a very large proportion of the construction materials, to do all hauling of supplies, and to provide electric power for construction operations, all at specified prices and rates. The specific reason for this decision by the owner to undertake hauling and to furnish materials is not made clear by the information at hand but the decision is in line with a growing engineering contract practice. Owners and their engineers on large operations are widely becoming suppliers of construction materials. This is relegating the contractor more and more to the function of construction plant expert and construction manager. The practice has a number of connotations which contractors will do well to consider and prepare to meet.

Ohioans Satisfied

OHIO cities seem well satisfied with the city manager plan. In the November election, charter amendments at Cleveland designed to end both the manager and proportional representation were defeated, notwithstanding a long campaign for them waged by their ex-governor proponent. At Cincinnati, the "charter party," or friends of the manager plan—the plan is combined there, as at Cleveland, with proportional representation—elected its ticket. Dayton, an early manager plan city, at first under Col. H. M. Waite, defeated one or more attempts to shake off the plan. Toledo has just voted for a charter commission to frame what is expected to be a manager charter, although presumably not of the standard council manager type. That such large cities as Cleveland, Cincinnati and Dayton should adopt and stand by the manager plan and a fourth Ohio city of size approve it tentatively will hearten those who believe not only in the plan but in its suitability for large as well as small cities.

Bridge Piers and Navigation

WHAT is adequate fender protection for a bridge pier that stands in a navigable channel subject to the danger of being struck by vessels out of control, lost in the fog, etc.? Opposite views on this question have been brought out in a series of hearings before the War Department that extended over a period of several months during the summer and early fall. The particular case under debate was the mid-channel pier of the highway toll bridge across Carquinez Strait in California; shipping interests were arrayed against the builders of the bridge on the subject of fenders. A description of the pier protection as finally approved by the War Department is published in this issue. The whole subject is of importance because much the same problem will be coming up in other locations—San Francisco Bay, for example, where the proposed San Francisco-Oakland bridge, if built, would have need for the highest type of protection for its channel piers in view of the traffic of large ships and naval vessels.

In the hearings concluded recently at Washington the point was made that a ship in collision cannot strike a blow greater than the shell of the vessel has strength to deliver. On this basis a pier fender would need to be only a reasonable amount stronger than the strongest ship with which collision might be expected. Shipbuilders have established a precedent in the design of hulls that is worth consideration in designing fender piers: ship construction practice does not design to resist the impact of full speed, or anything near full speed. No doubt it would be possible to construct ships so that the collision of two 20,000-ton vessels moving at 10 miles an hour would not stave in the hulls, but such construction would be very costly—unnecessarily so from an economic standpoint, because underwriters quote moderate insurance rates on vessels built to a much lower standard of strength.

The impact of a ship in collision with a bridge pier is not susceptible of exact analysis. To assume a certain rate of speed for a vessel of certain draft and weight, to assume that engines are shut off, but not reversed, at the instant of collision, and to stipulate the exact point and angle at which a prow of certain shape and structural strength would strike the fender structure, would be to agree on only the basis for further assumptions in analyzing a hypothetical collision. The angularity of impact is an important matter because at the relatively low speeds considered the prow of an oncoming vessel striking the fender pier at a sharp angle could undoubtedly be diverted if the fender "armor" were of the right character. Pointing a fender pier sharply up- and downstream increases the probability that collisions, when they occur, will be at sharp angles, and it is quite unreasonable to assume that a large vessel could be moving, end on,

at any considerable speed across a narrow channel. The maximum speed at which the vessel could strike the pier broadside is the speed of the tide plus the effect of the wind.

Assumptions and analyses of this kind serve to give some idea of the distance that a ship will plow into the fender or the extent to which the ship will be stove in by collision with that fender. The design used at Carquinez Strait is calculated to cushion the shock on the pier proper by using up the force of impact in crushing the fender and in cutting into the prow of the vessel. To this end the fender is designed as a concrete knife with the blade in a horizontal plane.

It is a subject of congratulation that the official decision took a reasonable view of collision possibilities and approved the fender construction. Shipping interests had repeatedly refused to accept modifications of the original plans, even those which the conservative War Department finally accepted. The outcome of the case supports the conclusion that proper consideration of the relative claims of land and water traffic is feasible without permitting domination by either.

An Interesting Sewage-Works Contract

A NOTABLE line-up of engineer and constructor is presented in the contract for the Akron sewage-works described in this issue. There is a general contract for construction. The engineer undertakes to supply certain materials for which he makes separate contracts synchronizing in time and volume of delivery with the progress schedule required by the general contract. The commitment of the constructor is that he shall furnish all other construction materials, provide construction equipment and labor and carry out all construction. Then the contractor makes separate contracts for the performance of special parts of the work synchronized in time with the general contract schedule. This contractual hooking up of engineer and constructor into close partnership in construction responsibility, and the extensive subdivision of the construction work, are interesting and significant.

The outstanding significance of the arrangement is that it recognizes the importance of continuity of purpose in the production of engineering works. Too often a design with plans and specifications is developed by the engineer and then, except for certain espionage duties, he ceases to function. The constructor in turn commits himself to no further responsibility than the production of a structure which satisfies the plans and specifications. There is not true identity of purpose nor real partnership of action unless the engineer and the contractor are both of the kind who voluntarily take on such a relationship as an extra-official function. Fortunately, there are many such instances. The significance of the Akron sewage-works construction plan is that it assumes from the first and provides throughout for identity and continuity of purpose of engineer and constructor. Both are committed by personal responsibility for parts of the work to its success as a complete construction operation. This is not too often the basis of conducting public works construction operations.

In another respect, as stated, the sewage-works construction at Akron is notable for the extent to which the general contractor has subcontracted special work. A universal custom in building construction, subcontracting has not been regarded with great favor in general engineering construction. At Akron it has worked reasonably well. Its applicability to sewage-works construction arises largely from the variety of radically different construction tasks. In this characteristic, sewage-works construction approaches building construction. As in large building work, too, these tasks amount to a sufficient volume of each kind of special work to encourage contractor specialists to seek it and to bid closely for it.

Forecasting and Forestalling Floods

IN A letter printed on another page, the Secretary of the Interior discusses the study of flood hazards. He states that his department is preparing to engage in such study on a broadly comprehensive basis, provided the engineers of the country can prevail upon Congress to authorize and finance the investigation. We ask the attention of our readers to the letter, and invite their co-operation individually and through their engineering societies in securing the necessary legislative action.

A most serious problem is involved. When floods sweep over the face of the earth and wreak havoc, men instinctively feel that they are helpless against such Acts of God, and must continue to bear them even in the future. Engineers know the error of this sentiment. They know that floods can be prevented or controlled by engineering skill. They can point to numerous successful examples of flood-protective work as witness. But they also know that controlling works can be carried out only if flood facts are so fully known that future events can be forecast with reasonable definiteness. At present, unfortunately, the knowledge of flood facts is quite inadequate. After a great flood the facts of that single flood are studied, too late to undo the destruction wrought. It is no doubt well to lock the stable door after the horse is gone; but our present problem is to lock it before.

To bring together all the flood facts which the different regions of the United States with their varied stream types afford is a task of most formidable size and difficulty. Exhaustive study is necessary, covering the interrelation of storms, runoff, and conditions in the drainage areas and channels. Such investigation has not yet been made save in fragmentary manner for a few small regions; the general study of flood data still remains to be carried out. And since without it no effective headway can be made against flood hazards, this study is among the most urgently important tasks ahead of us. The flood experiences of the present year, and most prominently those of the upper New England states two weeks ago, are manifest evidence of its urgency. But even if they had not come about, we could point to the regular sequence of other flood disasters of the past decade or two, striking now this valley and now that, but always unexpected and therefore overwhelming.

Since the task is of nation-wide scope, and of corresponding difficulty and cost, it is plainly the obligation of the federal government. The Interior Department is the natural tool of the government for this work. An appropriation of one hundred thousand dollars annually for three years would assure that the most difficult part of the task would be accomplished. There is no disposition in Congress, we know, to stand in the way of a vital undertaking. Once our legislators are convinced that the work must be done, they will provide the means. The responsibility for convincing them rests upon the engineering profession.

Sewage-Works Construction Methods At Akron, Ohio

Construction Operations Scattered over 300 Acres with Large Work Quantities Called for Transport Equipment of Exceptional Magnitude

THE NEW sewage-works at Akron, Ohio, furnishes a good example of the problems and practices of the constructor as they are presented and are being worked out in large undertakings of this type. In epitome, the characteristics of sewage-works construction are variety of processes, great volume of work, and wide spread of operations. Structurally the work is, on the whole, quite simple. The Akron works typify all these things and the plan of construction is in close coordination. Since, also, the work has shown steady good progress without display of extraordinary equipment or procedure, it offers an opportunity for plant and methods analysis giving results of general value.

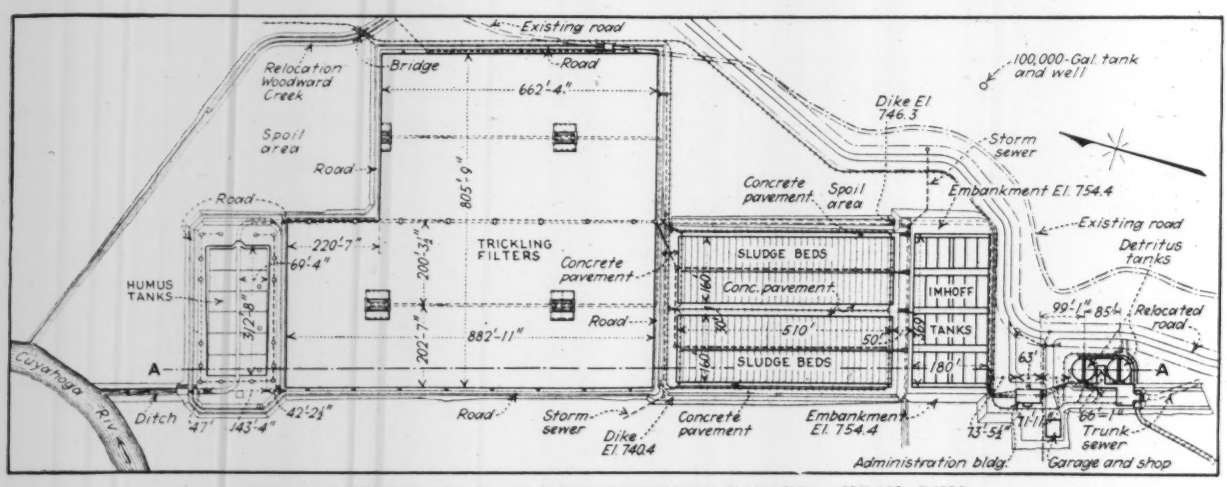


FIG. 1—OUTLINE PLAN OF SEWAGE-WORKS LAYOUT, AKRON, OHIO

Structures and Location—An outline plan and section of the Akron sewage-works are given by Figs. 1 and 2. In general, the structures are of the regulation character for such works: detritus tanks, Imhoff tanks, sludge beds, trickling filters and humus tanks. Some special details of design and structure, particularly the detritus tank design and operating mechanism, are planned for description at another time. Considered here solely as a construction task, the treatment structures are plain tank, wall, floor and conduit work in reinforced concrete with a measure of complexity in the Imhoff tank concreting. The true problem for the constructor existed not in the structures themselves, but in the volume of structure, the variety of tasks, and the large area of operations.

More than a hundred items of work had to be separated for computing quantities and asking prices. Volume is indicated by 336,000 cu.yd. of excavation, 33,000 cu.yd. of concrete, 312,000 tons of filter stone fill, 2,700 tons of reinforcing and structural steel, 3,600 tons of cast-iron pipe, over 1,000,000 filter floor tile, 800 valves and gates, 21,200 ft. of precast concrete piles and 127,000 sq.yd. of gunite, to quote less than ten of the hundred items. The structures extend half a mile longitudinally and have a maximum width of 800 ft. Including railway construction, river diversion, road relocation and spoil and storage areas, construction activities are distributed over some 300 acres and are intensive in an area of 40 acres. Variety, volume, and area of work are emphasized by these figures.

The works location is several miles from Akron. All structures are laid out on one side of a center line established with the idea of increasing capacity across the line when needed. In short, the present plant is laid out as one-half of an ultimate plant of two parallel units. The site is shown by Fig. 3. It is reasonably flat bottom on the east bank of the Cuyahoga River. On the opposite bank is the Baltimore & Ohio R.R., with a little local station called Botzum. On three sides are county highways, hilly and unimproved. There are only farms near by. Virtually the location is isolated, an advantage for sewage-works operation but a condition complicating the constructor's task by necessitating camps and collateral job services. In compensation, however, room was not restricted for these services or for stock piling or spoil disposal. The whole situation is well indicated by Fig. 3, and, as is noted later, bore importantly on the problem of construction access and plant arrangement.

Contract Procedure—In planning for contracting the work, the engineers chose, for reasons of control largely, to award a general contract for construction and equipment installation and separate contracts for appliances, as screens, meters and pumps, and for materials, as filter bed stone and cast-iron pipe. In all, a round dozen of these equipment contracts amounting to $825,000 were awarded. They were all strictly limited to furnishing equipment and materials; all stockpiling, placing and installing of materials and equipment were included in the

FIG. 2—DIAGRAM LONGITUDINAL SECTION OF AKRON SEWAGE-WORKS

general contract. The general contractor, however, elected to subcontract many items of special work as cement gun work and laying filter bed distributors. Altogether, the contract planning involved a subdivision of work between engineer, general contractor and subcontractors commonly found only in building construction. The fact is to be noted as indicating a trend in construction practice as it is being developed for large sewage-works and water-works filtration plants. The practice puts a heavy task of co-ordination on the constructor. The general contract was signed Feb. 25, 1926, and the other contracts at intervals thereafter.

Access and Plant Layout—Construction was begun March 8, 1926. The site was uncultivated land, generally level and without much growth to obstruct operations. There was a single county road direct to Akron, the only considerable nearby center for supplies and materials which was available by highway. The railway was on the opposite side of the river. It was, however, the logical means of access for materials and equipment of the volume and weight required by the work and the first main construction task was to develop this means by building a service railway from a siding put in at Botzum, across the river, and throughout the work as shown by Fig. 3. Meanwhile, the highways were used for trucking in materials and supplies, for establishing camp and for other preliminary work.

With the building of the railway, actual works construction was begun. Excavation was the first operation and is considered later. Simultaneously, plant installation went on. As indicated by Fig. 3, the main elements of the plant were: (1) The track system, reaching all the excavation, stockpile and spoilbank areas, (2) the service buildings and mixing plants all connected with the track system, (3) the two cableways spanning the width of the treatment structures and traveling their full length, and (4) the belt-conveyor installation for placing the filter-bed stone.

Two facts are to be noted: (1) The track system was arranged to serve all the other elements of the plant, and (2) virtually all operations were mechanized. The railway, cableways and conveyor, with serving cranes and excavators, could do all bulk handling of excavation, stockpiling, shifting and placing. Indeed, there was little carriage of any sort that required other means. Carriage, of course, was the bulk of the work and the plant arrangement and selection were pointed toward this function. Finally, it co-ordinated with the principal construction processes. These were excavation in which the railway, served by excavators, functioned largely alone; concrete construction in which the railways and cableways, served by cranes and mixing plants, functioned together; and installation in which railway, cableways and conveyors functioned in combination.

In all there were some six miles of standard-gage railway about half of which was permanent and half was being constantly shifted as the work advanced. The cableway tracks aggregated 14 miles. Other main plant items except cableways and belt conveyor referred to separately were: two locomotive cranes, four 50-ton locomotives, twenty-four 12-cu.yd. dump cars, one $1\frac{3}{4}$-cu.yd. and one $\frac{3}{4}$-cu.yd. dragline excavators, two 1-cu.yd. mixers, two inundators, two stone batchers, two 6-ton gasoline locomotives, three $2\frac{1}{2}$-cu.yd. concrete buckets, and five tractors and three motor trucks.

Excavation Methods—Excavation was the first major construction operation. Of the total 336,000 cu.yd., some 291,000 cu.yd. including topsoil, were for emplacements for structures and 45,000 cu.yd. for road relocation and stream diversion. For structures the yardage was divided about as follows: Trickling filters, 165,673 cu.yd.; Imhoff tanks, 45,400 cu.yd.; humus tanks, 28,700 cu.yd.; sludge beds, 19,200 cu.yd.; detritus tanks, 2,500 cu.yd.; and the remainder for other structures. Some 15,000 cu.yd. of the excavation had to be put into rolled embankment and refill and the topsoil, 12,468 cu.yd., had to be stored and replaced. With fine grading, the earth moving task was one of magnitude.

Topsoil removal was subcontracted and was done with elevating graders and teams. Excavation for structures was of interest chiefly in connection with the trickling filters and the Imhoff tanks foundations. They, too, contained the bulk of the yardage to be excavated.

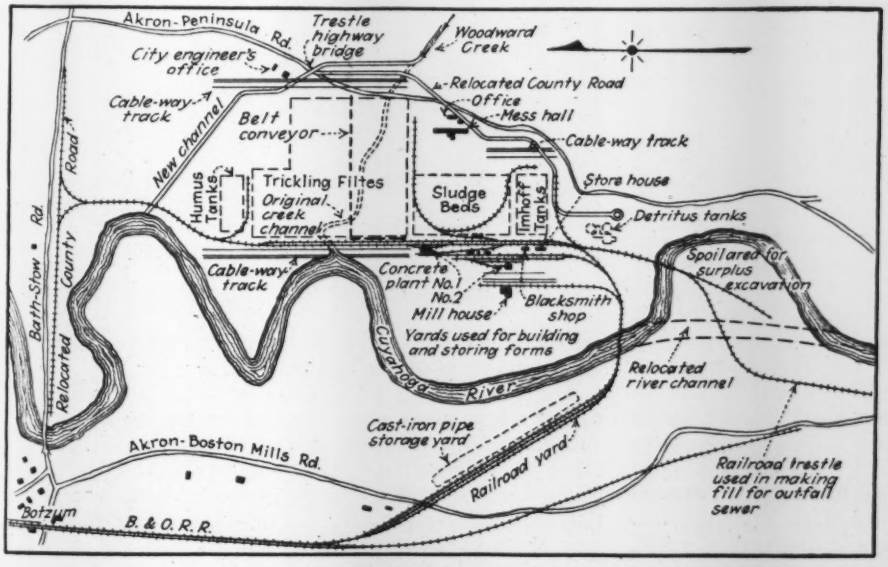


FIG. 3—CONSTRUCTION PLANT LAYOUT PLAN

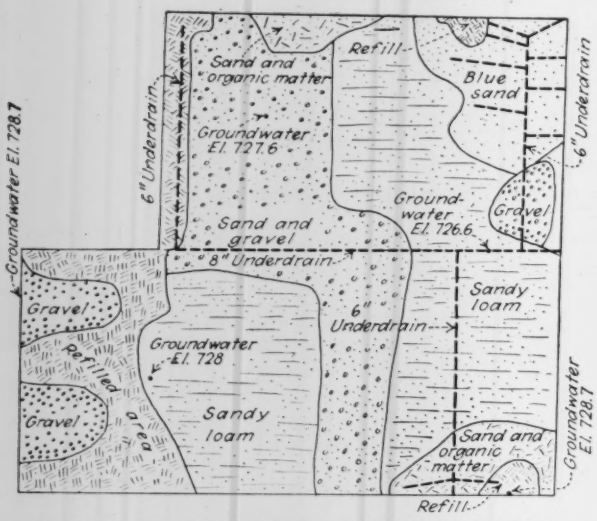


FIG. 4—SOIL AT GRADE IN SPRINKLING FILTER EXCAVATION

In the trickling filter emplacements, the material at grade is shown by Fig. 4. In general, it was good load bearing ground except areas at the north end and in two other places as is developed further on. Excavation was begun at the north end. Draglines traveling on the surface took the material out and loaded it into two 8-car trains of 12-cu.yd. dump cars which moved to the spoil areas or to whatever place fill was wanted. Both the 1¼-cu.yd. and the ¾-cu.yd. draglines were operated at different periods. Standard-gage track and equipment were used throughout, the track in the filter area being shifted with the excavation. The drainage problem was not difficult; Fig. 4 indicates the groundwater heights. Flow was to the underdrain along the north and south axis where a sump and 8-in. pump were put in. Later, other drains were put in in bad areas which developed.

Following the dragline work, a wheelbarrow gang did the fine grading. All conduit ditching was also by hand. Along the north end of the filter area a layer of muck required deeper excavation, about 3 ft., and refilling with sand and gravel taken from other areas. At the opposite end of the site, in the corners, two other bad spots of soft ground had to be underdrained and refilled as indicated in Fig. 4. All bulk excavation in the bad spots was done by draglines which also placed the refill.

The excavation for the Imhoff tanks (Fig. 2) was the deepest of all the work, averaging about 20 ft. Successive cuts were made across the pit, using the big dragline for the bulk work and proceeding from west to east. The material was 10 ft. of loam and gravel and below this a fine blue river silt. For the most part the pit was absolutely dry and required no sheeting. The blue silt was so still and dry that the hopper bottoms were roughly dug out with the small dragline and then fine graded (Fig. 5) with mattocks. But the silt was still only when dry. A sump and pump at the southwest corner due to the frequent rains became silted and the foot valve clogged so that this corner became water-clogged. The silt became like mush, the area had to be sheeted around and excavated, and the hole filled with lean concrete. At the east end where the excavation is against a hill, a slide had to be held back by interlocked steel sheeting and extra concrete was used later in the structure to give support against earth pressure.

The remaining excavation for structures and for road relocation and stream diversion was generally straightforward dragline and dump car work. However, the somewhat categorical account which has been given is only of importance as indicating the extent to which all earth moving demands were met by two methods of excavation, power shovels and draglines. Also, it is noteworthy how the dragline excavator adapted itself to rather close work as in the Imhoff tank bottoms. With concrete structure following the excavation closely, dragline digging and loading from the surface also guaranteed an unobstructed pit at the earliest possible moment.

Concreting Methods—The concreting arrangement worked out notably well. First, to get the arrangement in mind, the details may be run through. Concrete followed the excavation as closely as possible, the first being poured on the Imhoff tank bottoms, Fig. 6. The concreting plant layout is indicated by Fig. 3. Incidentally, it was thought at the beginning that one mixing plant and cableway would suffice for all the work but to keep up progress it was found necessary to install a

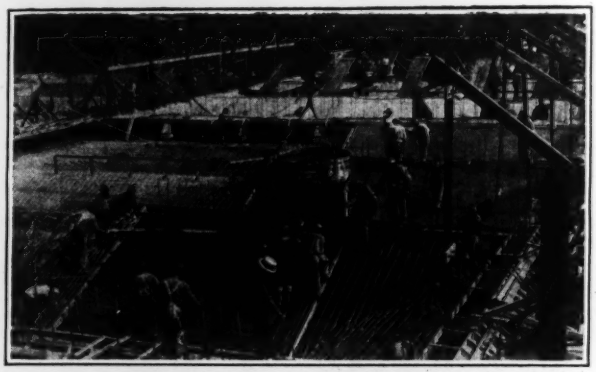


FIG. 5 (ABOVE)—FINISHING EXCAVATION FOR IMHOFF TANK BOTTOM

FIG. 6 (BELOW)—CONCRETING IMHOFF TANK BOTTOM

second like outfit. Procedure at both outfits was the same and that at one only is outlined.

The first mixing plant consisted of a 1-cu.yd. nontilting mixer with sand inundator and stone batcher surmounted by overhead bins and set high to discharge into a hopper over the railway tracks (Fig. 15) which discharged into 2½-cu.yd. buckets on flatcars hauled by gasoline locomotives, Fig. 17. In position under the cableway, the bucket was picked up and taken to the place of concreting, Fig. 6. After two months, the second mixing

FIG. 7—CONCRETE ROAD FINISHING MACHINE SURFACING FILTER BOTTOM

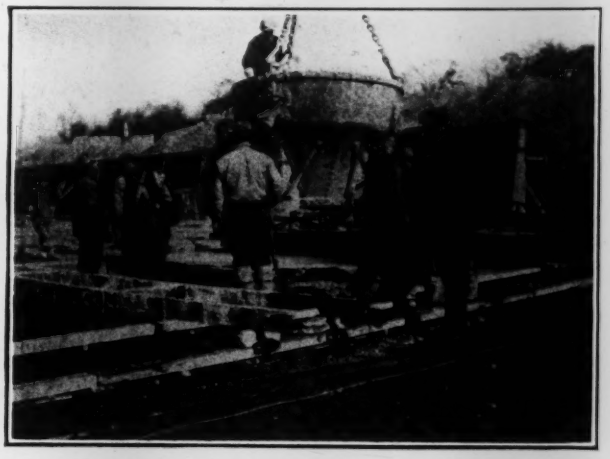


FIG. 8—DEPOSITING FILTER BOTTOM CONCRETE WITH 2½-CU.YD. BUCKET

plant like the first was installed and with the short-span, 658-ft. cableway was planned to concrete the sludge beds, Imhoff tanks and all the works south of them. The larger cableway had a span of 985 ft. and handled the trickling filter and humus tank operations from mixing plant No. 1.

Nominally six classes of concrete were required, but three of them, all 1:3:6 mixtures, were designated for foundation fills or, with cinder aggregate, for roof slab, as called for by the engineer. The three classes of structural concrete, all nominally 1:2:4 mixtures, varied only in the degree of slump permitted. For Class A concrete for tank bottoms, slabs on the ground and footings, the limit was a 4-in. slump; for all other concrete a 6-in. slump. Crushed limestone coarse aggregate was used, sand was constantly tested to check fineness modulus, and the slump was frequently determined. A clause allowed the contractor at his own expense to add cement and water to the mix to increase workability in the ratio of 1 bag to 6 gal. This privilege was taken advantage of in some parts of the work as is noted later.

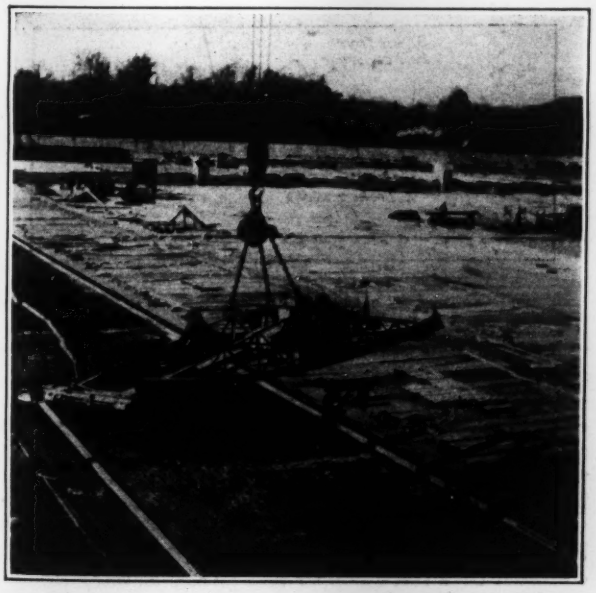


FIG. 9—CABLEWAY SHIFTING FINISHING MACHINE

The time of mixing was 1½ minutes, which meant at best a batch in 2 minutes. In fact, a good production was 25 batches in an hour.

The Imhoff tank and trickling filter work exemplifies placing problems and methods and their concreting alone will be especially described. In the Imhoff tanks no trouble was experienced in placing the bottoms, but the walls, because of the great amount of steel, offered a real problem. After the first pourings of walls, the workability of the concrete was modified by changing the ratio of fine to coarse aggregate. The forms were jarred with air hammers and about 15 men used in spading the concrete. This gave a dense concrete but the face showed up poorly in places. Additional cement and more water were refused the contractor and additional spading was

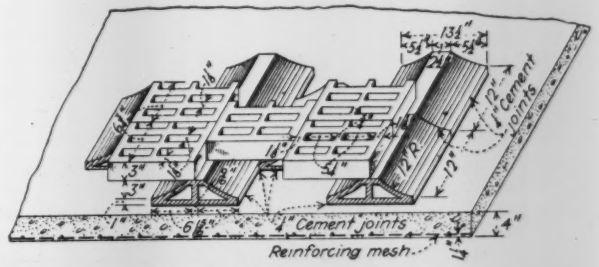


FIG. 10—TILE BLOCK FILTER BOTTOM STRUCTURE

ordered. This improved the work somewhat, but did not eliminate the trouble. The contractor then took off his air hammers and put the hammer men to spading and, surprisingly, the trouble virtually disappeared.

The hanging walls or lower-story ceiling walls were built with cement guns under a subcontract. These walls are thin and so heavily reinforced that concreting in forms offers great difficulties. Using the cement gun, only the under form is required. The subcontractor for this work not only put in the gunite, but built the forms and placed the reinforcement.

In the filter work some similar trouble was had with the wall faces and it was overcome generally by depositing in shallow layers to make the spading more effective. In some places, the contractor used additional cement and water as provided in the specifications. This resort was also required in concreting the collector channels where the invert and side walls were poured simul-

FIG. 11—GROUTING TILE JOINTS IN FILTER BOTTOM

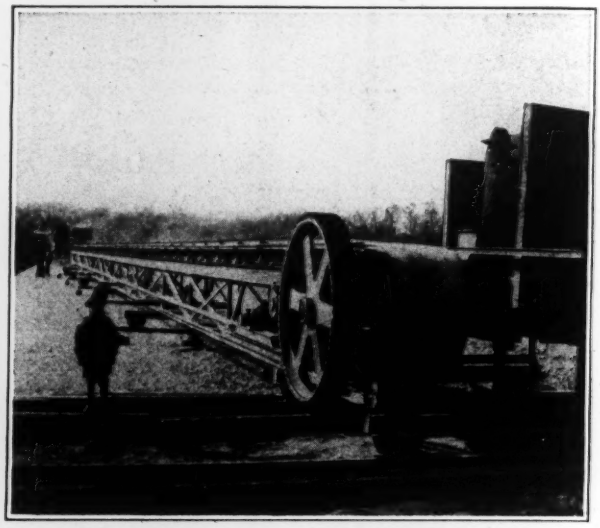


FIG. 13—BELT CONVEYOR DISTRIBUTING STONE FOR FILL

taneously. The novelty of the filter work was in the floor slab concreting. Virtually concrete road building processes were employed.

The 4-in. slab, mesh reinforced at the bottom, was laid down in 27-ft. strips. This width with the intervening slots—concreted later—left for forms divided the floor equally between crest and valley. Then strips of concrete, $1\frac{1}{2}$x6 in., were laid exactly to grade at crest and half-way down the slope to the valley. Over these and on the subgrade was laid the mesh reinforcement. Then plank side forms were set up. The floor strips between these were concreted much as is a concrete road using a finishing machine as shown by Fig. 7. The concrete was placed by cableway as shown by Fig. 8. The cableway also shifted the finishing machine from strip to strip, Fig. 9. With a clear way the finishing machine completed a 600-ft. strip in one working day. The slab was cured by covering with burlap and sprinkling for several days. An excellent floor, the engineers state, was secured by this process.

Filter Bottom and Fill—After the filter floor slab had cured two weeks, construction of the filter bottom was allowed. This was a new type and some study was required to develop methods. The construction, as shown by Fig. 10, is clay tile. The problem was to lay the pier-block tile so as to keep line and surface. The solution finally arrived at was as follows:

Parallel screeding strips of $\frac{1}{4}$-in. strap iron were laid on the floor exactly defining the zone occupied by a row of blocks. Between these strips a mortar grout was poured and screeded flush. In this grout the pier blocks were set by pressing and shoving so as to obtain a push joint. As soon as a row of blocks was in place, a line was stretched and the blocks were tamped to perfect alignment. When the mortar had set a few days the joints between blocks were filled using a torpedo can, with grout mortar, Fig. 11, for the longitudinal joints and wire brushes and stiff mortar for the transverse joints. When this mortar had set, the joints were scraped smooth with long-handled chisel-shaped tools. The arch block were then set without mortar and the bottom was ready for the filter stone.

Placing the stone fill employed one of the largest units of equipment on the operation. The filter bed was approximately 800 ft. square with one corner mortised out as shown by Fig. 1. The fill was 10 ft. deep, of crushed limestone, about 223,000 cu.yd. altogether. This stone was delivered in twin-hopper-bottom cars on a track along the west side of the filters. Filling was begun along the north wall, using cableway and bucket to place the first windrow or strip of fill. The special belt-conveyor plant was then put in operation. This consisted of a track hopper and bucket elevator loading to a belt conveyor along the west filter wall. This feeder,

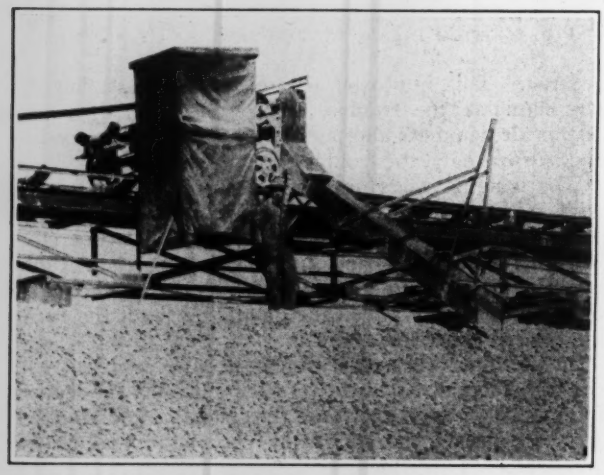


FIG. 12—TRIPPER ON BELT CONVEYOR PLACING STONE FILL

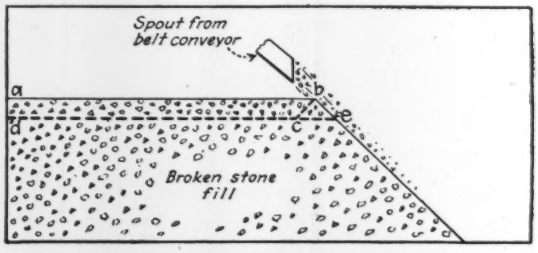


FIG. 14—FORMING DISTRIBUTOR TRENCHES IN STONE FILL

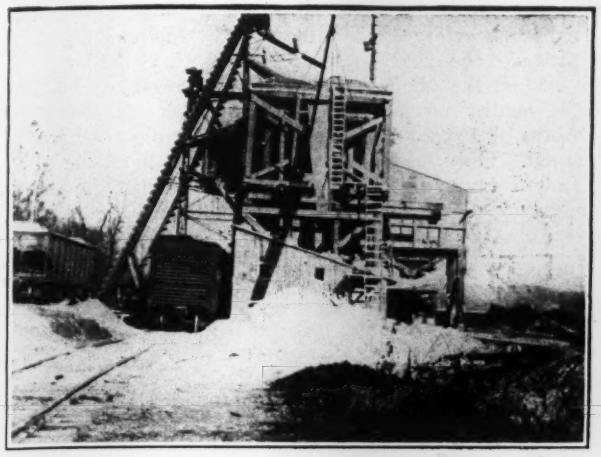


FIG. 15—CONCRETE MIXING PLANT, GENERAL VIEW

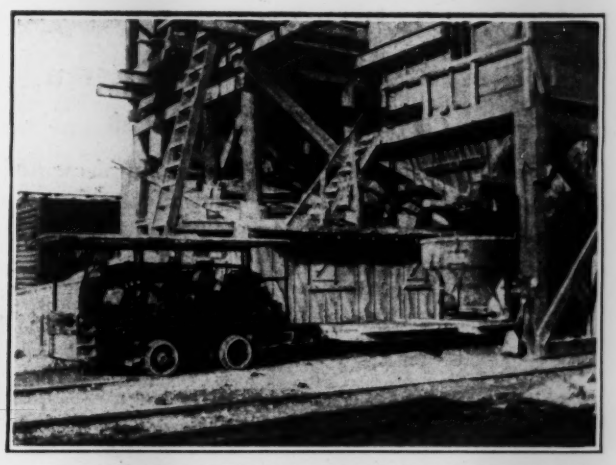


FIG. 17—CONCRETE TRAIN LEAVING MIXING PLANT

or shuttle-belt, conveyor-loaded onto a distributing conveyor spanning the filter from west to east. The shuttle conveyor was 200 ft. long and the distributing conveyor was first 400 ft. and later 800 ft. long, for reasons seen from the plan, Fig. 1, and had a traveling tripper discharging to a spout, Fig. 12. A view along the distributor is shown by Fig. 13, and shows how it moved sidewise as the fill progressed.

With this stone-placing equipment there was very little handwork beyond keeping the top of the fill level at elevation with two or three men casting over the edge as the stone might pile up unevenly. As the fill was placed, too, the trenches for the distributor pipes were formed as shown by Fig. 14. With the top of the fill at *a b*, the trench bottom is indicated by *d c*. As the fill slope was extended the little triangle *c b e* of fill where the trenches came was pushed by shovelmen over the slope. This made very easy the usually hard work of digging long trenches in a broken stone surface. Another

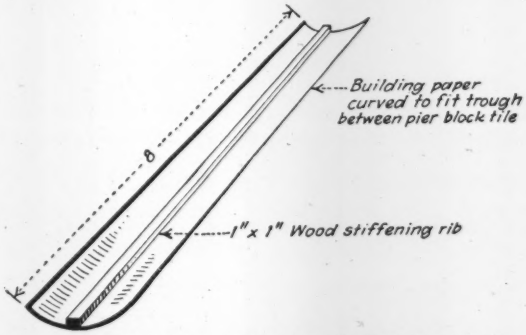


FIG. 16—PANNER TO CATCH STONE FALLING THROUGH COVER BLOCKS

device of the constructors in placing the fill was a home-made panner for catching the small stones which fell through the tile cover block slots into the channels between pier blocks. This is indicated by Fig. 16. These panners were shoved into the channels where filling was in progress and caught the passing stone. As the fill advanced they were pulled out and emptied and then reinserted.

Co-ordinate Operations—In founding and concreting other structures than the filters and Imhoff tanks there were essentially no methods and equipment employed which departed importantly from those described. Installation of equipment and services was very largely subcontracted to specialists who followed customary methods. This was true of special building work, guniting the Imhoff tanks, etc. Co-ordination and control was the critical task. The control was rigid through close inspection and constant testing. Similarly, a close accounting checked progress and performance. None of these features demands especial mention.

Governing Requirements—The governing requirements of the construction task were co-ordination and transport. The methods of both have been indicated. The many different and distinct kinds of work, the separate contracts for construction and for equipment and materials, 13 contracts in all, and the wide subcontracting policy of the contractor for construction, called for careful organization and management to dovetail the many operations into a continuous, orderly sequence. The procedures followed were not unusual, but the requirement itself calls for notice as a governing characteristic of sewage-works construction.

Transport was the large technical problem. The transport system had to perform both volume and variety of carriage. With one exception, the belt conveyor, there was not a one-function transportation unit on the operation. Both service railway and the cableways were general carriers. In particular the cableways deserve note for their universal service both of carriage and placing. They handled virtually every kind of thing employed in or for construction. Altogether, the transportation plan and equipment on the Akron work deserves close attention.

Co-ordination has already been emphasized. It was exhibited in the handling of the working forces as well as in the broader tasks previously mentioned. There was much inclement weather in the first year (1926) of operation. There were 113 rainy days from March to December; the total precipitation was over 40 in.—in one month, September, it was 12 in.—and there were 59 days of frost. The time lost because of inclement weather was five days. This record was had despite a large labor turnover encouraged by the constant rainfall. As an illustration, in September there were 15 days of rain, a rainfall of 11.98 in., and 900 men were hired to maintain an organization of 500 men.

Direction—The sewage-works at Akron are being constructed by the Department of Public Service, W. F. Peters, director. J. E. Root is engineer of the Bureau of Sewers and A. B. Backherms is resident engineer on the work. The general contractor is the Walsh Construction Co., of Davenport, Ia.

Operating Results of the Essen Activated-Sludge Plant

Sludge Digestion in Imhoff Tanks Supplemented by Separate Digestion in Tank Heated by Its Own Gases

By Dr. Karl Imhoff
Chief Engineer of the Ruhrverband, Essen, Germany

Translated from the German
By Gordon M. Fair
Assistant Professor of Sanitary Engineering, Harvard University, Cambridge, Mass.

THE activated-sludge plant at Essen-Rellinghausen (*Engineering News-Record*, Aug. 19, 1926, p. 298) has been in operation since December, 1925, Fig. 1. It serves 45,000 people and receives a dry-weather flow of 5.8 m.g.d. or 130 gal. per capita. The wooden paddles, constituting the mechanical agitation device, used in combination with compressed air, have continued to show their usefulness. Air consumption is only 0.08 cu.ft. per gal., the period of aeration is 3½ hr., and the entire power consumption is 7 hp. per m.g. The quantity of returned sludge is 8 per cent of the incoming sewage, based upon measurement after the sludge has stood one hour in an Imhoff cone. The amount of return sludge pumped, however, is twice as great (16 per cent), because the sludge is not allowed to compact in the hoppers of the secondary sedimentation tanks. The quantity of excess sludge produced daily, as measured in the condition in which the sludge is pumped, is 0.5 to 1 per cent of the sewage. The clarification is good, its "transparency" generally being 6 ft. (see Table I for further analytical data).

TABLE I—ANALYTIC RESULTS AT ESSEN-RELLINGHAUSEN ACTIVATED-SLUDGE PLANT

Results stated in p.p.m.

	Raw Sewage	Effluent from Imhoff Tanks	Effluent from Activated-Sludge Plant
Suspended solids	180	120	6
Mineral	29	60	5
Organic	151	60	1
Total solids	1,014	1,016	953
Mineral	805	793	771
Organic	209	222	183
Oxygen consumed:			
Not filtered	532	350	30
Filtered	196	196	30
Biochemical oxygen demand:			
Not filtered	310	204	17
Filtered	133	133	17
Chlorides	84	84	83
Sulphates	339	338	300
Ammonia nitrogen	23	23	21
Organic nitrogen	7	7	4
Iron	2	2	0
pH	7.5	7.5	7.2

The excess sludge is pumped to the preliminary settling tanks (Imhoff tanks) and is there digested together with the sludge derived from preliminary clarification. The figures given in *Engineering News-Record*, June 4, 1925, relative to the quantities of sludge produced and reduction by digestion in the volumes of the sludge, have proved to be correct (Table II herewith).

TABLE II—SLUDGE PRODUCTION AND DIGESTION AT ESSEN

	Liters per Capita per Day	Per Cent Water
Fresh sewage sludge	0.9	95
Digested sewage sludge	0.2	80
Excess activated sludge	2.5	98
Digested activated sludge	0.16	80
Total digested sludge	0.36	80

When the plant was first put in operation, however, the quality of the digested sludge became worse and worse, because the digestion compartments were too small. Only 0.73 cu.ft. per capita are available in the Imhoff tanks and 0.36 cu.ft. per capita in the supplementary digestion chamber; a total of 1.09 cu.ft. per capita. The supplementary separate digestion tank, in particular, was inefficient because it was cold. This difficulty was overcome by heating.

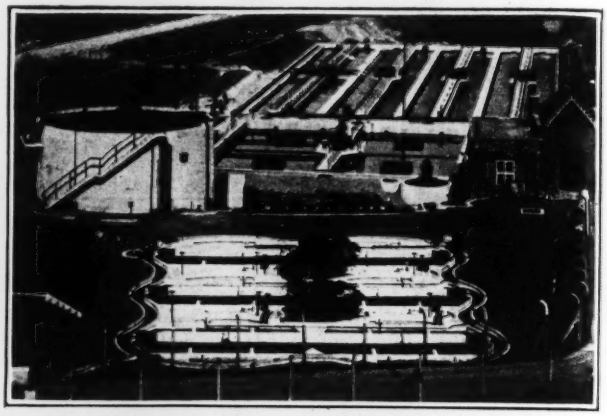


FIG. 1—GENERAL VIEW OF ESSEN-RELLINGHAUSEN SEWAGE-WORKS
In the foreground are the Imhoff tanks; behind them to the left the heated supplementary digestion tank and to the right the power house; in the center are the secondary settling tanks; in the background are the aeration units.

The method of heating selected (Figs. 2 and 3) was one that had been tried in 1921 in another plant at Essen. Water from the pressure water supply mains is raised to 70 to 80 deg. C. in a boiler heated by sludge gas and is then introduced directly into the sludge at the bottom of the digestion tank.

The difficulties experienced wherever heating coils passing through the sludge have been used are thus avoided. The hot water makes its way through the sludge to the surface and during passage gives up its heat. It then flows with the sludge liquor to the preliminary clarification tanks. Only 800 gal. a day of water are used. The temperature in the sludge tank which, prior to heating, had been 8 to 9 deg. C. has since been

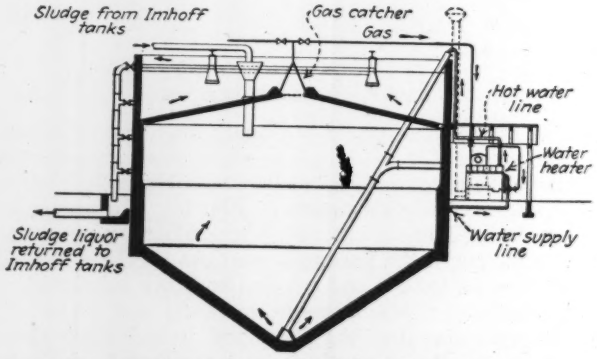


FIG. 2—SUPPLEMENTARY DIGESTION TANK HEATED BY ITS OWN SLUDGE GASES
Hot water introduced into the sludge at the bottom of the tank serves as the heat exchanging medium. Only 800 gal. a day of hot water are used.

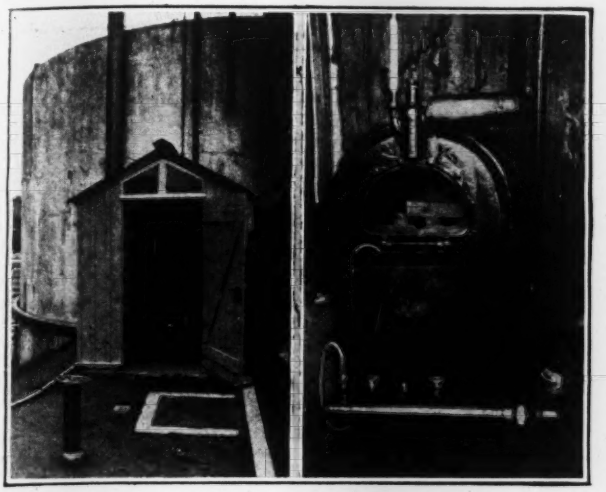


FIG. 3—SUPPLEMENTARY DIGESTION TANK WITH HEATER

At the left, heater building in front of tank. At right, looking into heater building; gas pipe in front; water supply pipe in back; insulated hot water pipe at top.

maintained at 21 deg. According to the temperature curves of Fig. 4 this means a tenfold increase in gas production and with it in digestion tank efficiency. Only the gas produced in the supplementary digestion tank itself is burned up; the remaining gas originating in the Imhoff tanks is sold, as before, to the municipal gas works.

Since introducing the heating of the supplementary digestion tank the digestion chambers, in spite of their small capacity of 1.09 cu.ft. per capita, take care of all the sludge, both the preliminary tank sludge and the excess activated sludge. The total quantity of sludge has approximately doubled and amounts to 0.36 l. per capita per day. The quality of the digested sludge is good; nitrogen content increased from 1.2 to 2.3 per cent.

It should be noted that the separate digestion chamber is not protected against cold. The vertical concrete walls are exposed to the air. Apart from the gas catcher (Fig. 2) located below the water surface there is no other cover. The scum presents the only protection against cold. The gas catcher, made of tongued-and-grooved boards, has proved its worth.

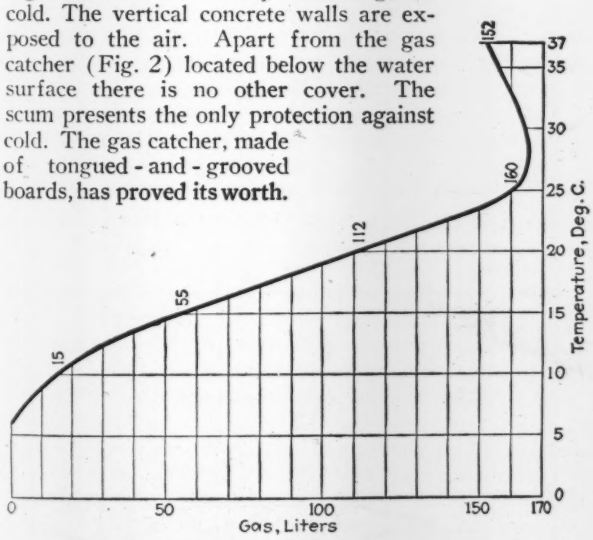


FIG. 4—GAS PRODUCED BY 1 KG. OF SLUDGE AT DIFFERENT TEMPERATURES

After Dr. Sierp. The fresh sludge was inoculated in a ratio of 1:1 with digested sludge. The water content of the mixture was 85 per cent. Period of digestion, 57 days.

The total gas production from all digestion compartments which amounted on an average to 6 l. per capita daily decreased during the first period of operation of the activated-sludge plant, because the digestion chamber capacity was too small for so large an amount of sludge. Since heating has been introduced, the old figure has been exceeded and the quantity of gas continues to rise. The composition of the gas has changed in so far as the CO_2 content has increased somewhat. The methane content is still over 73 per cent.

TABLE III—PERCENTAGE COMPOSITION OF SLUDGE

	Fresh Sludge from Preliminary Settling Tanks	Activated Sludge After Settling 1 Hour	Digested Sludge—Before Introducing Excess Activated Sludge	Digested Sludge—After Introducing Excess Activated Sludge
Water	....	96.1	78.1	80.0
Dry residue	....	3.9	21.9	20.0
Composition of dry residue:				
Mineral matter	32.6	41.8	65.9	47.9
Organic matter	67.4	58.2	34.1	52.1
Nitrogen	2.5	3.0	1.2	2.3

The construction costs are now $90,000, exclusive of the preliminary clarification units which date from earlier times. The cost of operation is $12,500 per annum.

Protection for Highway Bridges Over Railway Tracks

Abstract from a Report given at the recent Convention of the American Railway Bridge and Building Association.

FOR highway bridges over railway tracks, the best floor is that which has the least vibration, is watertight and also fireproof. The concrete floor over a properly designed substructure best meets these requirements. For heavy traffic, the slab should be waterproofed and given an independent wearing surface of concrete, brick or asphalt, preferably concrete. For medium or light traffic, the concrete slab itself should be satisfactory. Wear or cracks can be taken care of with an application of bituminous material, but this should be done in time, so that the floor will be kept watertight. The high cost of a good concrete floor will be more than offset by the lack of maintenance cost and the inconvenience in maintaining any other class of floor for heavy or medium traffic.

For light traffic, where the entire structure is to be new or renewed, concrete should be used in preference to the best wood floor. This may require a better and more expensive substructure, but steel substructure and concrete floor would cost little more than a steel structure with wood floor, even taking into account the added amount of steel required to carry the concrete floor, while the additional cost would be saved in renewals in a comparatively short time. In many cases existing steel bridges might, without undue expense, be reinforced to carry a concrete floor.

Where concrete slabs are used, the waterproofing membrane is best of burlap or cotton cloth, felts being eliminated because their stiffness renders them not adaptable for covering irregular surfaces or working into corners. Burlap is highly hygroscopic but has the advantage over felts of greater tensile strength and greater flexibility. Cotton cloth has none of these objections, but to be permanently waterproof must have its fibers thoroughly saturated with asphalt.

When wood floors must be retained, there should be a treated sub-floor not less than 3 in. thick and a wearing surface not less than 2 in. Instead of frequent replacements of plank in repairs, more consideration should be given to making such floors as permanent as possible. Thick flooring permits a wider spacing of stringers and thus reduces the pocketing of engine gases under the floor. Wood floors should have a bituminous surfacing 1 to 2 in. thick.

Test of Full-Size Suspension Type Transmission Tower

Vertical, Longitudinal and Transverse Loads Applied to 80-Ft. Tower to be Used on Conowingo Power Line

A STRUCTURAL steel tower to be used for the power transmission line of the Conowingo hydroelectric development near Philadelphia (*Engineering News-Record*, Dec. 23, 1926, p. 1024) was recently subjected to full-size tests, carried out in an interesting way. The tower withstood the loads for which it was designed and finally was tested to failure.

The standard tower is 80 ft. in height, square in section, with the base 33 ft. on a side. The waist of the tower is about 20 ft. below the plane of the three conductors, from which point the sides of the tower are flared outwardly to provide the necessary electrical clearance

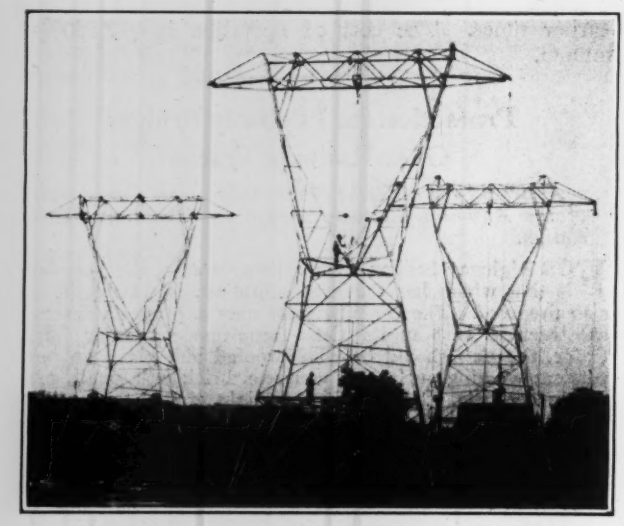


FIG. 1—GENERAL ARRANGEMENT OF TESTS
Tower under test is to the right and rear.

for the middle conductor. The two ground wires are carried approximately 16 ft. above the plane of the conductors and midway between them. Connections are all field bolted. The total weight of the tower above ground is approximately 7 tons. A structural steel tripod extending 7 ft. below the ground from each leg is normally used as an anchor, while for special construction a concrete footing is used, into which an extension of the main leg is anchored.

The towers will be spaced about 1,100 ft. apart, and the wires, which are suspended in releasing clamps, will have about a 30-ft. sag. These releasing clamps are so designed that an unbalanced pull, which will produce a longitudinal swing of 20 deg. of the insulator, will completely release the clamping mechanism. The wires then are held only by the friction in the saddle of the clamp. By means of these clamps the longitudinal pull from a broken wire is restricted to a small fraction of the ultimate tensile strength of the wire. On this account the design of the tower is considerably lighter than would be possible without the use of these clamps.

As the tower was too large to test in the usual test

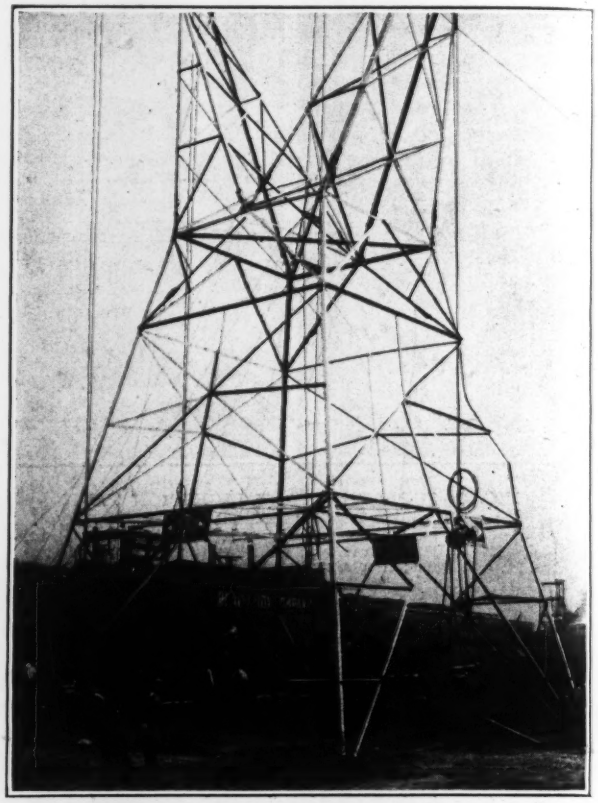


FIG. 2—TOWER AFTER BEING TESTED TO FAILURE
Increasing the transverse load as a final test caused the main leg angle to buckle.

frame, two similar towers were erected for the test, one beside and the other in front of the test tower and about 100 ft. away. Loads were applied to the tower by means of weighted platforms supported from the test tower by means of pulleys and cables. The test tower was equipped with 24 electric strain gages, which were read as increments of the test loads were applied to the structure. Movement of the tower was noted by transits set up on two sides of the tower and levels were used to measure any movement of the anchors.

Vertical, longitudinal and transverse loads were applied to the tower at the five points at which the wires are supported. Various combinations of loading were made to simulate actual service conditions. Failure

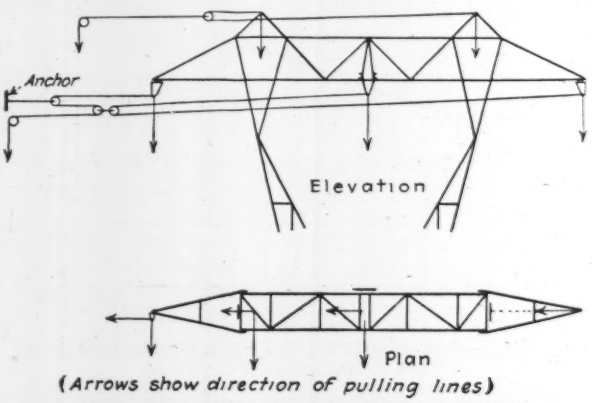


FIG. 3—PLAN AND ELEVATION OF TESTING ARRANGEMENT

occurred after all tests had been made and was brought about by increasing the transverse load to 27,990 lb. or over 70 per cent above the design load, at which time the tower was also subjected to a 30,875-lb. vertical load and a 10,000-lb. longitudinal load.

The test was carried on at the plant of the Blaw-Knox Co., Pittsburgh, Pa., where the tower was fabricated. Day & Zimmermann Engineering & Construction Co. has the contract for the design and construction of the Conowingo transmission line for the Philadelphia Electric Power Co. and the Susquehanna Power Co.

A similar full-size transmission tower test was carried out in California a number of years ago and was described in *Engineering News-Record*, Sept. 1, 1921, p. 350.

Steel Viaduct to Be Reinforced by Encasement

Corrosion of Plate Girders Carrying High St. Over Railroad Tracks in Columbus Necessitates Strengthening

By R. H. Simpson
Chief Engineer, Department of Public Service, Columbus, Ohio

HIGH ST., in Columbus, Ohio, is carried over the tracks of the Pennsylvania R.R., the C. C. C. & St. L. Ry. and the Union Depot Co. on a viaduct of four 75-ft. spans. The structure consists of deck girders about 4½ ft. apart, carrying buckle plates to support the floor. It has a clearance of 16½ ft. above the railway tracks. The viaduct was built in 1895, at the joint expense of the city and the railroad companies. By reason of the limited clearance, the sandblast action of locomotive exhaust and the action of gases on the steel has caused serious deterioration, resulting in heavy expense for maintenance. In 1912 a careful investigation showed that the flange plates and the stiffeners of many of the girders were greatly reduced in cross-section and the web members of some of the girders were rusted through. Following this inspection, the badly rusted girders were strengthened by the addition of new flange plates, stiffeners and web plates.

Some two or three years ago a careful inspection disclosed further deterioration and indicated that the structure should be rebuilt. Accordingly, preliminary studies were made and an estimate of cost prepared for a complete renewal of the structure. At the time these studies were being made it was suggested that this structure could be strengthened by the use of reinforcing rods and cement mortar applied by means of a cement gun. Such repairs to the structure, if effective, would mean that it could be put in a safe condition with no interference with traffic. This is an important consideration, inasmuch as the main entrance to the union station leads from the viaduct, and a complete renewal would require some temporary construction to provide access to the station.

About this time some tests were made at Ohio State University on a few old I-beams, which indicated that the strength of the old steel beams could be increased within reasonable limits by the addition of steel rods and the encasing of the entire assembly in cement mortar applied by means of a cement gun. They also showed that the strength of such reinforcing beams might be predicted accurately by the usual theory of composite beam action. The results of these tests were given in *Engineering News-Record* of April 7, 1927, p. 574, by J. R. Shank.

Notwithstanding the successful results of these tests at Ohio State University, it was felt that this method of strengthening should not be adopted for the High St. viaduct without some further investigation as to its effectiveness when applied to the field under adverse conditions. It was therefore proposed that some tests be made on two girders of the High St. viaduct, in order to check, if possible, the results obtained on the encased I-beams tested in the laboratory. An appropriation was secured to carry on this field test. Careful caliper measurements of the actual cross-section of the two girders were made at intervals of about 5 ft., and with these measurements as a basis the reinforcing and the gunite encasement were designed to provide the required strength. Before and after encasement a test load of motor trucks was placed over the two girders and the deflections and tension in the bottom flanges of these girders measured. The results showed that the reinforcement and encasement had stiffened the girders enough to reduce deflections under live-load about 11.6 per cent and reduce the live-load unit stresses about 13.5 per cent.

These tests further demonstrated that it would be possible to design a steel and gunite reinforcement for the girders on the viaduct which would effectively strengthen them and protect the steel from further corrosion, so that the present structure would continue to give service for a long period of time, depending upon the rate of abrasion of the mortar encasement by the cinder blasts from locomotive stacks and the corrosion of the encasement due to gases from the engines.

It was estimated that the cost of the encasement of this structure, including the reinforcing steel, would be $112,000, while the construction of a new viaduct would entail an expense of $175,000 and in addition would necessitate the construction of a temporary roadway to handle traffic to and from the union station, besides seriously interfering with the traffic on High St. In view of all the facts it was decided to adopt the reinforcing plan. Financial reasons, however, made it preferable to do at this time only that part of the work which is immediately necessary. Accordingly, after receiving bids, a contract has been awarded to The Fritz-Rumer-Cooke Co., of this city, to encase about 40 per cent of the girders in the viaduct, the work to start immediately. It is expected that funds will be available during 1928 to complete the work. This project, while under the general direction of the writer, is under the personal supervision of R. C. Chaney of the city engineering department. Prof. Clyde T. Morris was employed as consultant in connection with the stress deflection measurements and the design of the reinforcement.

No Trees for Roads Less Than 80 Ft. Wide

Planting trees on California highways will in future be done only on such roadways as have a right-of-way not less than 80 ft. wide, according to an announcement by Bert B. Meek, new director of public works in that state. This decision was reached because of the belief that in many cases trees planted along a 60-ft. right-of-way will later have to be moved to make way for widening.

Designing a Fender for a Bridge Pier in Midchannel

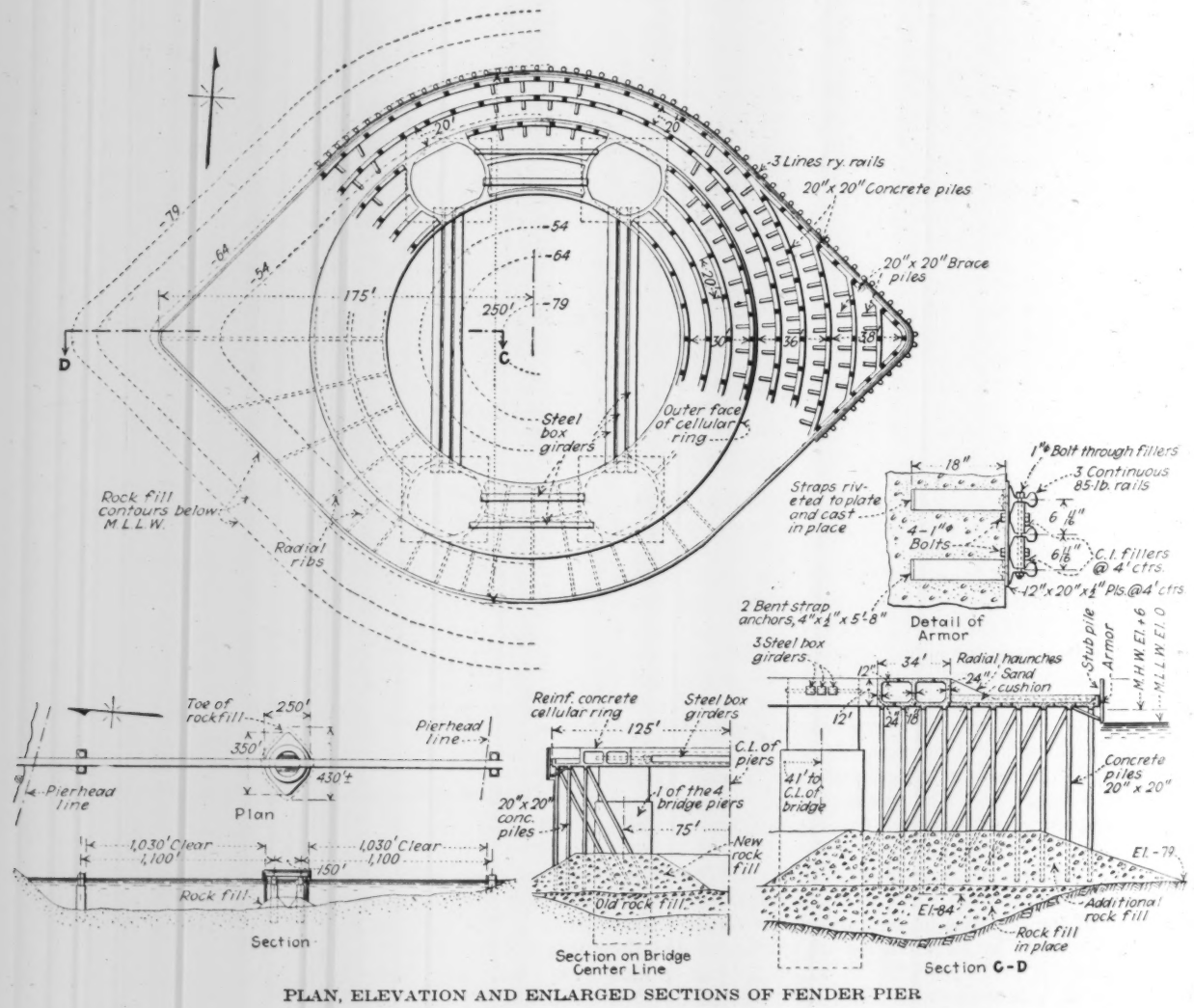
Central Pier on Carquinez Bridge to be Encircled by Cellular Concrete Girder—Massive Structure on Rock Fill

THE HIGHWAY toll bridge across Carquinez Strait in California has main channel spans that give 1,030 ft. in the clear on either side of the central pier. Through these two channels must pass all the shipping that moves to and from the upper bay waters. The central pier supporting these two long spans thus stands where it is necessary to provide some safeguards against damage in case the pier should be struck by a vessel out of control, lost in the fog or being carried by wind and tide. The design of the fender was influenced by the fact that the water depth here is 85 ft. and that the four cylinder piers, 40 ft. in diameter, have a total length of 135 ft. Thus the total height of the pier and its surmounting tower of steel is about 440 ft.

The question as to the best type of protection has been under consideration since the earliest plans for the bridge were drawn but difficulty in reaching agreement with shipping interests necessitated many hearings and so delayed matters that plans only recently received final approval of the War Department. For descriptions of the bridge as a whole, see *Engineering News-Record*, May 12, 1927, p. 777, and previous articles therein referenced.

After the bridge was opened to traffic and pending a settlement of controversies over the design of a permanent fender around the central pier, temporary protection has been provided by four ships anchored and fastened to the pier as shown in the accompanying picture. The ships were supplemented by steel box girders between the cylinders that constitute the four supporting legs of the pier superstructure, and also by a heavy timber dock or guard on the north and south faces of the pier cluster.

The permanent fender will consist of a rock fill, placed around the pier cluster, into which 20 x 20-in. concrete piles will be driven, some vertical and some inclined, to support the superstructure or fender proper. This will be a very heavy reinforced-concrete deck, ribbed with girders and beams, both circumferentially and radially, whose shape will be, in plan, a pointed ellipse, the points extending up and downstream from the pier cluster.



PLAN, ELEVATION AND ENLARGED SECTIONS OF FENDER PIER

These tapered tips are to deflect the prow of an approaching vessel wherever possible and the use of an armor of steel rails, as shown, is to aid in this function.

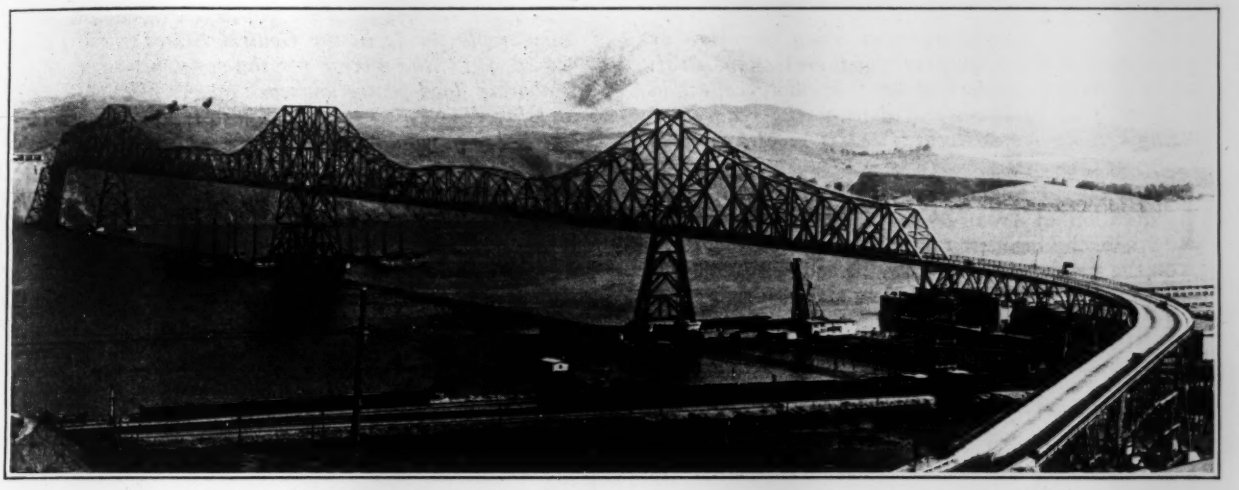
In principle the fender will be a massive structure, cast monolithic with the four cylinder piers so as to hold them rigidly together, opposing the entire mass of the combined structure to the collision of a ship. There are two main features of this design, first, the circular reinforced-concrete girder of the cellular type that will enclose and tie together the tops of the four supporting piers, and, second, the deck of the deflector which forms a plate, or knife, with its blade in a horizontal plane, designed to cut into a vessel and thereby to absorb the destructive energy in the event of a violent collision.

In other words, in the event of a head-on collision that cannot be deflected by the armor, the relatively thin concrete slab is expected in part to cut into the structure of the vessel itself and in part to be cut by the vessel, thus avoiding the transmission of direct, uncushioned impact to the central elements of the structure that supports the tower above.

Supplementing the tie afforded by the encircling concrete girder, the cluster of four supporting piers is connected on all four sides by groups of steel box girders as indicated in the drawings. The ends of these girders, which are $3\frac{1}{2}$ x $4\frac{1}{2}$ ft. in section, are embedded in the caps of the circular bridge piers as shown. The deflector or deck is covered with a 4-ft. layer of sand not primarily to increase the mass but rather to provide a deck loading sufficient to resist the tendency to uplift that results when horizontal impact is transmitted to diagonal brace piles.

Proceeding according to these plans, the bridge company has already placed the steel box girders connecting the four piers and when this article was written was preparing to call for bids on the rock fill. Special means of getting this fill into place are being considered because the water depth and tidal current preclude the satisfactory placement of graded material by the ordinary method of dumping.

The Carquinez bridge is owned and operated by the American Toll Bridge Co. for whom Charles Derleth, Jr., Berkeley, Calif., is chief engineer and George J. Calder, resident engineer. F. G. White and H. E. Squire, both of the California State Harbor Commission, San Francisco, were associated with Professor Derleth in the design of the fender pier.



CARQUINEZ BRIDGE, SHOWING TEMPORARY FENDER PROTECTION FOR CENTER PIER

Long Water Tunnel in Great Britain

BEN NEVIS, highest mountain in Great Britain, is being pierced by a tunnel which will utimately be 16 miles in length. It is required for conveying water to the turbines of a hydro-electric plant which is being installed. The tunnel will be 16 ft. in diameter. In order to expedite the work, twelve side adits were driven at intervals throughout the length of the main tunnel, and when these reached the main tunnel position, boring was started to the right and left until the next boring face from the adjoining adit was reached. There are thus 24 faces available, which make it possible to put more men to work, and thus to complete the job in a shorter time.

Adequate ventilation was essential in order to carry out the work—not only to furnish a supply of fresh air at the workings, but also to remove the fumes and dust produced by the blasting operations. At the entrance of each of the 12 adits there is a motor-driven fan which draws the foul air through sheet metal ducts away from each of the two working faces, causing thereby a constant circulation of fresh air throughout the tunnels. Altogether, these 12 fans are moving about 300,000 cu.ft. of air per hour, two further fans of a similar type being employed as boosters.

Australian Transcontinental Railway

After several years of surveys and studies for a north-and-south transcontinental railway in Australia, involving the crossing of deserts where transportation by camels is now necessary, the federal government has awarded a contract for a 275-mile stretch of railway extending north from the present end of line at Oodnadatta, in South Australia, to Alice Springs. A line extends south from Port Darwin, on the north coast, to Emungalan, 150 miles. From Emungalan to Alice Springs there will still be a gap of about 720 miles to be closed. For the new extension, the government will supply the material, the contract being for labor and amounting to about $3,476,000.

Flood Rainfall in New England

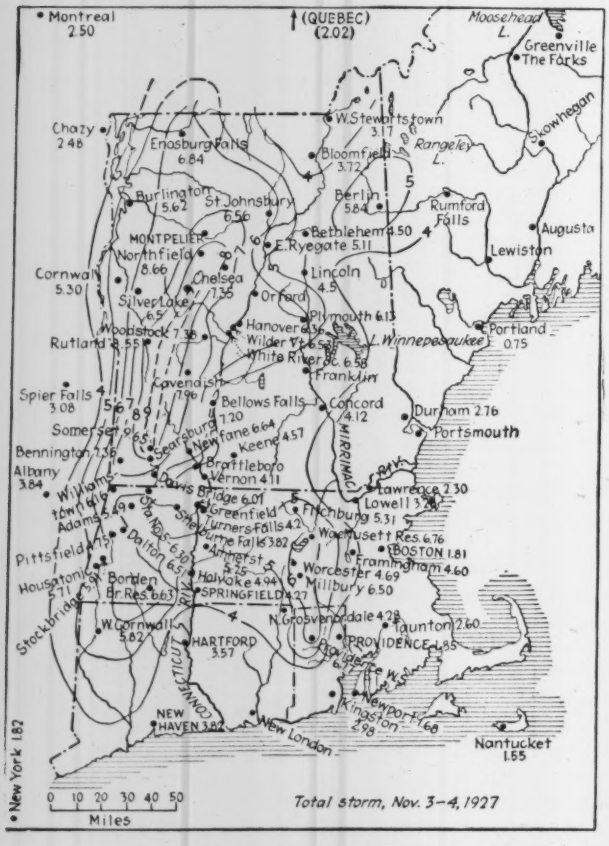
Plotted Rainfall Figures Show Storm Was of Great Magnitude, Though Surpassed by 1869 and 1897 Storms—Heaviest Rainfall in Region of Greatest Destruction

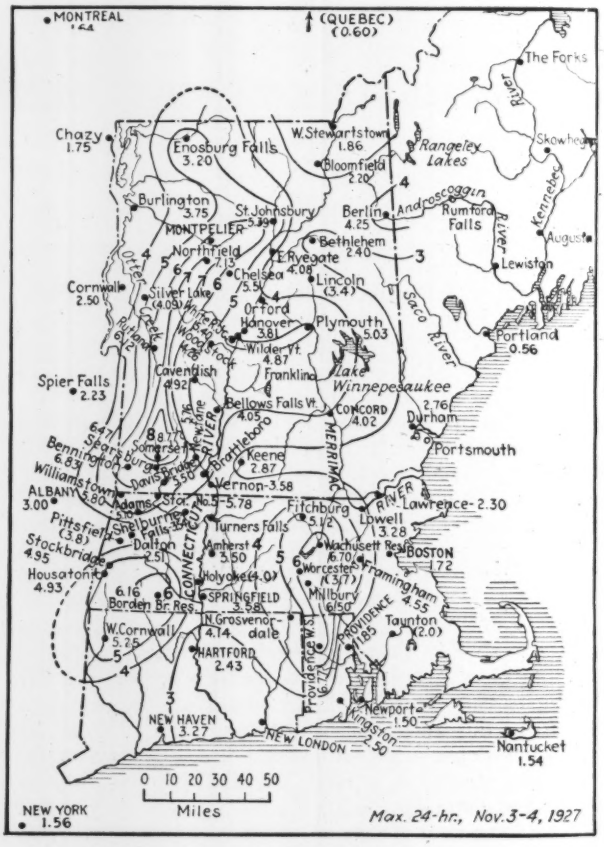
By H. K. Barrows
Professor of Hydraulic Engineering, Massachusetts Institute of Technology, and Consulting Engineer, Boston, Mass.

[Life and property losses in the New England storm-flood of two weeks ago at once marked out this storm as one of the major meteorological events of this part of the earth's surface. Its full study at the earliest possible moment being therefore of fundamental significance to flood protection, Prof. H. K. Barrows undertook an immediate collection and mapping of the storm data at the request of "Engineering News-Record." His results confirm the advance impression that the storm was of remarkable intensity and size, though in extent it was apparently exceeded by the storms of 1869 and 1897. It was more intense than the storm which caused the memorable floods in the Central States on March 24-26, 1913, the motive for the construction of the elaborate flood-protection work on the Miami River in Ohio. The 2-day precipitation in Vermont equaled the 3-day precipitation in the Miami area.—EDITOR.

THE New England storm of Nov. 3-5, 1927, had a duration of from 24 to 48 hours. In Vermont, where the heaviest rainfall occurred, the storm began on the evening of Nov. 2 and lasted nearly 48 hours. In western Massachusetts and New Hampshire it covered about the same period of time. In eastern Massachusetts and Rhode Island it was practically confined to the day ending Nov. 4 at 8 a.m., with most of the rainfall during the latter 12 hours. In Maine it began early Nov. 4 and extended into Nov. 5.

Precipitation Records—In the appended table are given precipitation data at many New England stations and a

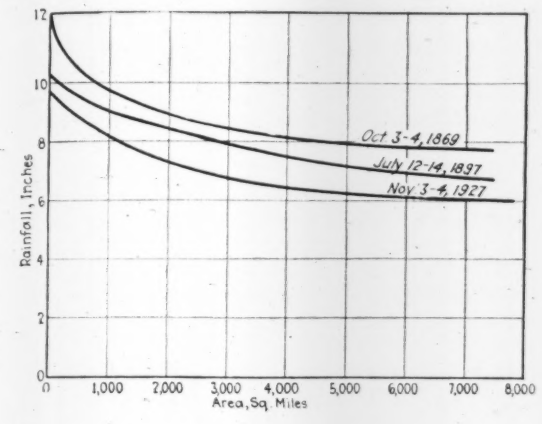


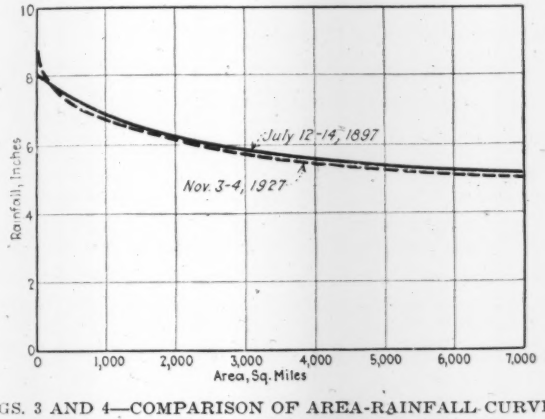


FIGS 1 AND 2—ISOHYETAL CURVES FOR NEW ENGLAND STORM OF NOV. 3-4, 1927

For the total storm the areas of the principal isohyetals are approximately: 9 in., 340 sq.mi.; 8 in., 1,200 sq.mi.; 6 in., 7,500 sq.mi.

Figures for Hartford, Conn., furnished by C. M. Saville after the maps were drawn, given 3.98 in. at West Hartford watershed (6 mi. west); 6.14 in. at Nepang watershed (18 mi. from Hartford) and 6.76 in. at East Branch watershed (22 mi. from Hartford). These figures indicate that the curves in the left hand diagram require some modification in the vicinity of Hartford.





FIGS. 3 AND 4—COMPARISON OF AREA-RAINFALL CURVES FOR THREE GREAT NEW ENGLAND STORMS

The 1869 storm was probably the greatest ever experienced in New England. Nevertheless, the 1927 storm caused higher flood stages in the lower reaches of the Connecticut River.
Curves for the total storm are shown above (Fig. 3).
Curves for the maximum 24-hour period are below (Fig. 4).

few in New York and Canada showing (1) the total precipitation of the storm and (2) that for the highest day or 24-hour period.

This information has been obtained largely by telegraph from the various observers and may be subjected to some correction when more time is available. The amounts for the maximum day are undoubtedly too low in some cases owing to the manner of observation—in general at 8 a.m. each day. There is, however, enough information to give a reasonably accurate picture of the situation, and the writer wishes here to acknowledge and express his appreciation for the prompt response to all inquiries made.

A comparison of the total rainfall for the storm with that for the maximum day shows the following:

Locality	Ratio Max. Day / Total Storm
New Hampshire	0.75
Vermont	0.77
Western Massachusetts	0.82
Connecticut	0.85
Weighted Mean	0.80

From the above it will be noted that over three-fourths of the total rainfall occurred in a 24-hour period in the area of highest rainfall, Vermont and western Massachusetts.

Isohyetals—The tabular data have been plotted on a map of New England and isohyetals drawn, as shown in Figs. 1 and 2, for (1) the total storm period and (2) the maximum day.

A recorded maximum of 9.65 in. for the total storm occurred at Somerset, Vt., with 8 in. or more at several stations near central Vermont and in the Green Mountain range. The 9-in. isohyetal probably covered a narrow strip extending approximately north and south for

PRECIPITATION IN INCHES—STORM OF NOV. 3-4, 1927

Station	Total for Storm	Maximum Day	Elevation Ft.
Maine			
Portland	0.75	0.56	....
Androscoggin River	5.25	....	....
Kennebec River	3.43	....	....
New Hampshire			
Berlin	5.84	4.25	1,000
Bethlehem	4.50	(3.4)	1,470
W. Stewartstown	3.17	1.86	1,914
Lincoln	4.5±	(3.4)	1,000
Plymouth	6.13	5.03	500
Hanover	6.36	3.81	603
Durham	2.76	2.76	88
Keene	4.57	2.87	506
Concord	4.12	4.02	350
Vermont			
Burlington	5.62	3.75	404
Newfane	6.64	5.76	550±
Northfield	8.66	7.13	876
Somerset	9.65	8.77	2,096
Vernon	4.11	3.58	310
White River Jct.	6.58	5.40	360±
Davis Bridge	6.01	5.50	1,400±
Sherman	4.00	....	....
Cornwall	5.30	2.50	507
Woodstock	7.38	4.26	700
Silver Lake	6.5	(4.9)	....
Bennington	7.36	6.83	700±
St. Johnsbury	6.56	5.39	711
Enosburg Falls	6.84	3.20	601
Chelsea	7.35	(5.5)	840
Bloomfield	3.72	2.20	900
Rutland	8.55	6.12	550±
Cavendish	7.96	4.92	....
Bellows Falls	....	4.05	....
Plant 5—N.E.Pr.Co.	6.30	5.78	1,000±
Searsburg	7.20	6.47	1,500±
E. Ryegate	5.11	4.08	....
Wilder	6.53	4.87	400±
Massachusetts			
Boston	1.81	1.72	124
Worcester	4.69	(3.7)	514
Nantucket	1.55	1.54	47
Pittsfield	4.75	(3.8)	1,050
Holyoke	4.94	(4.0)	....
Chestnut Hill	2.31	2.24	....
Spot Pond	2.01	1.85	....
Framingham	4.60	4.55	....
Clinton	6.76	6.70	....
Lawrence	2.30	2.30	51
Lowell	3.28	3.28	80
Taunton	2.60	....	40
Turners Falls	4.2	....	200
Williamstown	6.16	5.80	711
Housatonic	5.71	4.93	....
Dalton	6.51	2.51	....
Near Springfield			
Borden Br.	6.63	6.16	....
Mundale Filters	6.41	5.61	....
Provin Mt.	4.19	2.87	....
City Hall	4.27	....	199
Ludlow Res.	4.24	3.58	....
Shelburne Falls	3.82	3.54	....
Stockbridge	5.91	4.95	....
Adams	5.49	5.10	....
Fitchburg	5.31	5.12	550
Millbury	6.50	6.50	....
Amherst	5.75	3.5	222
Rhode Island			
Providence	1.85	1.26	160±
Newport	1.68	1.50	40†
Kingston	2.98	2.50	250
Providence Water Supply Board			
Fiskville	4.83	4.83	260
Kent	7.51	7.51	....
S. Scituate	6.80	6.80	280
Hopkins Mills	7.85	7.85	450
Rocky Hill	6.86	6.86	440
Weighted average	6.77	6.77	....
Connecticut			
Hartford	3.57	2.43	159
New Haven	3.82	3.27	127
W. Cornwall	5.82	5.25	....
W. Grosvenordale	4.28	4.14	400
New York			
Albany	3.84	3.00	97
Spier Falls	3.08	2.23	380
Chazy	2.48	1.75	200
New York	1.82	1.56	97
Canada			
Montreal	2.50	1.64	....
Quebec	2.02	1.22	....

about 70 miles, as shown. The greater amounts of rainfall occurred within the state of Vermont.

It is probable that the rainfall exceeded 10 in. at the higher elevations in the Green Mountains. It is to be noted that the area of excessive fall included the headwaters and considerable portions of Otter Creek, the Winooski and White Rivers, on which the greatest flood damage occurred.

The 6-in. isohyetal extended into New Hampshire and Massachusetts, with a secondary or local 6-in. isohyetal of about 350 sq. miles area between Worcester, Mass., and western Rhode Island.

For the 24-hour period the recorded maximum was 8.77 in. at Somerset, Vt., but approximately 7 in. fell at several stations. The isohyetals for Vermont are somewhat similar in shape to those of Fig. 1, but differ considerably in the other states.

The approximate areas covered were:

Isohyetal In.	Area Sq. Miles
8	100
7	640
6	2,300
5	6,800

Previous Great Storms in New England—There were two great storms which occurred previously—those of Oct. 3-4, 1869, and of July 12-14, 1897—which are comparable with the recent storm.

The storm of Oct. 3-4, 1869, is noted as the largest on record in the last 50 years (see Technical Reports, Miami Conservancy District, Part V, p. 138), with a maximum of 12.35 in. in 36 hours at Canton, Conn. No 24-hour records are available for this storm. It was more widespread than that of 1927, including all of New England and extending as far south as Virginia. It resulted in the highest stages on the Connecticut River for a period of 100 years.

The storm of July 12-14, 1897, was a New England storm of short duration, 30 to 36 hours, with greatest intensities in western Connecticut and Massachusetts. The maximum rainfall recorded was at Southington, Conn., with 10.3 in. in 33 hours (Ibid., p. 145).

To compare the 1927 storms with these two, rainfall-area curves for 48-hour and 24-hour periods, respectively, are plotted in Figs. 3 and 4. On Fig. 3 these curves include the 1869, 1897, and 1927 storms and on Fig. 4 those of 1897 and 1927.

It will be seen that *the storm of 1927 covered lesser areas* for different amounts of rainfall *and had a lesser recorded peak* than either of the earlier storms. For the 24-hour period, however, the 1927 storm shows a greater intensity for areas less than about 300 sq.miles and slightly less intensities for greater areas, the curves lying close together. Keeping in mind that the 1927 storm occurred late in the fall (after comparatively recent previous rainfall), as compared with July for the 1897 storm, it is evident that drainage area conditions favored a higher runoff for the recent storm. Furthermore, the two streams where perhaps the worst conditions prevailed flow in the general direction (northerly) of the storm movement, thus tending toward a somewhat higher flood peak.

Few runoff data are available as yet, although it is known that the Connecticut River from Vernon to Holyoke exceeded in flow all previous records, including the storms of both 1869 and 1897. An estimate of the flow of the Winooski River near Burlington given in last week's *Engineering News-Record* showed a peak of 100,000 sec.-ft. from 1,000 sq.miles—a relatively high flood runoff. When data become available for the upper portions of the streams heading in central Vermont they will doubtless show very high flood peaks, perhaps in excess of any previous figures for New England.

The rainfall in the recent storm was especially noteworthy, therefore, in respect to maximum 24-hour amount—reaching and exceeding in numerous localities all previous records. While the storm for its whole period did not exceed those of 1869 and 1897 in rainfall, its circumstances and time of occurrence and resulting runoff were such as to cause much greater loss of life and damage to property than any previous storm.

River Conditions in Flood Area of New England

Stream-Flow Data Lacking, but Reports Indicate Unprecedented Floods in Some Rivers—Merrimac and Dog River Data

FLOOD conditions in many of the New England streams appear to have exceeded all prior records, although the storm itself was not as intense as that of 1869 (see figures and maps given by Prof. H. K. Barrows in the preceding article). In the lower course of the Connecticut unprecedented stages were reached. In upper New England the severity of the damage on some of the rivers suggests higher floods than any previously recorded. The only definite figures so far available are given below.

The river systems of New England that went into flood caused by the heavy rains of Nov. 2 to 4 are shown by the accompanying map. The Connecticut was in flood from its source to the sea, as also most of its tributaries. Most of the latter, as the map shows, lie on the western side of the stream, and of these the Passumpsic, in northern Vermont, caused the most damage—at St. Johnsbury and points east. Towns on the main stream suffered heavily but the Vermont-New Hampshire towns are relatively small, and the damage in them was chiefly to bridges, highways, railways and mills. At Springfield and West Springfield, Mass., and at Hartford, Conn., the homes of thousands of people were flooded.

Vermont was hardest hit in the valleys of streams tributary to Lake Champlain, cities and farm lands on Winooski River from Barre and Montpelier to Burlington and Winooski being by far the worst sufferers in loss of life and property, as reported in *Engineering News-Record* last week. To the northward, the Lamoille and the Missisquoi wrought much damage, and to the south, Otter Creek, the latter chiefly at Rutland and vicinity. In southeastern Vermont and northeastern Massachusetts, the Hoosac River was high, with much damage at North Adams, Mass., and on to the Hudson River. In southwestern Connecticut, Winsted, Waterbury and Ansonia, on the Naugatuck, which reaches Long Island Sound through the Housatonic, felt the flood. South central Massachusetts sent flood waters to Narragansett Bay by way of the Blackstone through Worcester and Woonsocket. A considerable area in Maine, New Hampshire and northwestern Massachusetts poured large volumes of water into the Atlantic, through the Androscoggin, the Kennebec and the Merrimac.

Flood volumes on the Merrimac at Concord and Man-

chester, N. H., were less on Nov. 5, 1927, than on March 2, 1898, according to figures sent *Engineering News-Record* by George G. Shedd, of L. H. Shattuck, Inc., engineers and contractors, Manchester, N. H. At Manchester (drainage area, 2,839 sq.mi.) the runoff was 75,000 sec.-ft. or 26.4 per sq.mi., in 1896, against 72,000 and 25.4 in the 1927 flood. At Concord (2,300 sq.mi. area) the corresponding figures were 69,000 and 30 against 64 and 27.8. The gage heights at Concord were 13.5 in 1898 and 12.2 in 1927; at Manchester, 10.95 against 9.2 and 11.2 (second dam?).

Northfield, Vt., the seat of Norwich University, 10 miles south of Montpelier, on Dog River, a tributary of the Winooski River, was one of the high rainfall points. A delayed report prepared for *Engineering News-Record* by Prof. W. D. Emerson and Prof. J. S. S. Jones, of the engineering faculty, contains rainfall and gaging station data thus summarized: The total rainfall was 8.63 in., exceeding the 40-year mean for November by about 6 in., and that of any month during the same time by some 2 in. Rain began to fall between 9 and 10 p.m., Nov. 2. The heaviest precipitation was at the rate of 0.62 in. per hour, during a 6-hr. downpour beginning at 11 a.m., Nov. 3, when the stream was already bankful. The rain continued intermittently until 4 p. m. Nov. 4.

An automatic recording stream gaging station maintained by Norwich University is located at Kingston bridge, one of the few bridges in Northfield that stood. Quoting from report by Professors Emerson and Jones:

> The well [of the gage] lacked depth enough to allow full range for the float. At the peak of the flood the time relation on the record is uncertain for about nine hours, but with aid from the Weather Bureau record and with knowledge of the action of the water farther downstream, it was possible to reconstruct fairly accurately this portion of the record. Between 1 a.m. and 6 p.m. on Nov. 3 water rose at the gage 8.7 ft. and in the next 24 hr. fell 4.5 ft. As the gaging station is one and one-quarter miles above the village, this rise did not compare with that experienced in the village, where backwater effects from debris, bridges, and one dam sent the water to a height of at least 15 ft. above its level at the beginning of the storm, this having been determined by spirit levels on flood marks on houses.

RIVERS IN NEW ENGLAND FLOOD ZONE
Scale, 43 miles per inch

Flood Effect on Sharon Dam on the White River

THE effect of the flood of Nov. 3-4 on the Sharon concrete dam, located on the White River, in Vermont, and on a timber crib dam ten miles downstream, built in 1796, is reported by R. R. Marsden, dean of the Thayer School of Civil Engineering, Dartmouth College, under date of Nov. 15, as follows:

> I have just returned from a trip to the Sharon dam on the White River and find the damage to the dam was not as great as first reported to me (see *Engineering News-Record*, Nov. 10, 1927, p. 773).
>
> The dam is of concrete, gravity section, on piles driven 4 ft. c to c., with a row of triple piling under the toe. The

north end of the dam entered a sandbank. High water carried away a section of the crest 150 ft. long by 4 ft. deep. The water then cut around the north end of the dam and there is at present a channel 30 ft. wide at that point. The highway opposite the end of the dam was eroded to a depth of 40 ft. and was entirely destroyed for a distance of one quarter mile below the dam. As this channel was formed, the water cut under the upstream end of the north abutment. The abutment broke away from the main dam and tipped upstream into the hole thus formed. Except for the loss of the crest the main section of the dam appears to be uninjured.

Ten miles below the Sharon dam is an old dam which came through the flood apparently without injury. It is a timber crib dam, 400 ft. long and 9 ft. high, securely pinned to the ledge, and was built in 1896.

Vibrolithic and Plain Concrete Road Slab Tests

COMPARATIVE transverse bending tests on year-old slabs of normal and of Vibrolithic concrete by the Bureau of Public Roads show, under the test conditions, higher strengths for the Vibrolithic concrete. A duplicate series of slabs 28 days old was tested in 1926 and the results were published in *Engineering News-Record*, May 13, 1926, p. 779. The present tests conclude the investigation undertaken "to obtain data on the resistance to rupture by bending, of specimens of different mixes fabricated by each of the two methods." These tests, it is stated, must not be considered "as a complete comparative study of Vibrolithic and normally finished pavements." One kind of aggregate and hand finishing only were employed, and the results obtained apply only to them.

Four mixtures of concrete were used: 1:1½:3½; 1:2:3½; 1:2:4, and 1:2:4½. The test slabs were 36 in. wide, 72 in. long, and 6 in. thick. The coarse aggregate was limestone, graded from 2 in. to ¼ in. The fine aggregate was clean and fairly coarse river sand. A carefully blended portland cement of good quality was used. A correction was made for the bulking of the sand. The consistency for both types of slabs was maintained at about a 2-in. slump, or a flow of 110 to 115 on the 30-in. flow table, using a ⅛-in. drop.

The concrete was placed in the forms, tamped and struck off with a straight 2x12-in. strike board worked lengthwise over each group of five slabs. The normal finishing consisted of belting lengthwise over the slabs with an 8-in. rubber belt. The Vibrolithic concrete was covered uniformly with limestone of 2-in. to 1-in. size at the following rates per square yard respectively for the four mixtures: 50 lb.; 50 lb.; 45 lb., and 40 lb. The special slatted platforms were placed on this stone and the vibrators were run over them, according to the patented process. The irregular mortar surface left on the removal of the platforms was smoothed down with a long-handled steel float, after which the surface was belted.

All slabs were covered with wet burlap kept damp until the following day, when they were covered with damp earth. This earth was kept damp for 28 days, after which it was removed and the slabs for testing at 28 days were broken. The rest of the slabs, i.e., the one-year specimens, were left on the original subgrade during the remainder of the year and were covered with earth and kept wet for the 28 days immediately prior to testing in order that the concrete in all the specimens should be in as nearly a uniform condition of moisture as possible at the time of the test. The results of the tests are summarized as follows:

1. For a given cement content the slabs constructed by the Vibrolithic method showed greater strength than those of normal concrete, when measured by the transverse bending test.

2. The Vibrolithic concrete slabs were somewhat more uniform in strength than those of normal concrete in both the 28-day and 1-year tests, both types showing greater uniformity at 1-year than at 28 days.

3. The specimens of Vibrolithic concrete showed a greater percentage of increase in the modulus of rupture from 28 days to 1 year than did those of normal concrete.

4. Absorption tests on 6x6-in. drilled cores indicate that there is practically no difference in the absorptive properties of the two types of concrete.

5. Compression tests on 6x6-in. drilled cores tested at the ages of 13 and 17 months do not show the difference in strength between normal and Vibrolithic concrete that is indicated by the transverse bending tests.

6. The value of the modulus of elasticity ranges from 3,000,000 to 6,000,000 lb. per sq.in. for both these types of concrete. The average value of E is somewhat higher for the Vibrolithic concrete than for the normal concrete by both the bending and compression test determinations.

Testing Welds Under Field Conditions

Where welding is done in the field, as in pipe-line construction, periodic testing of a welder's ability is often difficult. The followng information, abstracted from *Oxy-Acetylene Tips* for November, 1927, outlines some of the methods for field testing of welds now in use. One of the simplest tests to apply in the field is that of bending the welded coupon in a vise until the first signs of fracture are noted. In evaluating the results of such a bending test, it has been customary to measure the angle of the bend in accordance with the standardized method of the American Welding Society. This ordinarily requires a large machine. Recent investigations have shown that the measurement of elongation rather than the angle of bend is a more accurate indication of quality of weld. This means that the bend tests can now be applied under field conditions so as to give numerical results. In making such a test, gage marks are put on either side of the weld and the specimen bent. It has been found that the best results may be obtained by first starting the bend about ½ in. from each side of the weld by light hammering. The specimen is then inserted in the vise so as to bring pressure on the ends, which causes the coupon to take on a uniform curvature as the vise is tightened. Bending is carried to the first sign of cracking, after which elongation may be easily measured by a flexible scale. As an indication of what may be expected in an average weld, the elongation should be about 20 per cent for a weld made in mild steel plate. As a further aid in testing operators under field conditions, a portable tensile testing machine, which will take a short specimen similar to that used in regular testing laboratory machines, has also been developed to test specimens cut from welds in a line. For cutting the specimens one oil company is said to have obtained splendid results with a portable keyway slotting machine fitted with two thin milling cutters and a spacer in place of the broad milling cutter used in normal operation.

Spreading Pavement Assessments, Lake Worth

Special Staff and Methods Employed to Keep Rotation Fund Active and to Speed Computations on $10,000,000 Job Involving 1,000,000 Sq.yd. of Pavement

By Gardner Boyd
Lake Worth, Fla.

LAKE WORTH, FLA., whose first settlers began clearing away the palmetto not much longer ago than 1912, has under way at the present time a contract for municipal improvements involving the construction or rebuilding of more than a million square yards of pavement, which, with curb and gutters, sidewalks, and a complete system of storm and sanitary sewers, is expected to cost when completed in the neighborhood of $10,000,000. All these improvements are to be paid for by direct assessment against the abutting or benefited property, covered by bond issues running over a period of from one to ten years. A general bond issue of $800,000 was sold before work started to provide a rotating fund to pay the contractor as the work progressed and to be renewed as the assessments are collected. On completion of the work and the issuance of the last improvement bonds, the rotating fund will be available either to reduce taxes or to pay for other municipal improvements.

Due to an embargo on freight on the Florida East Coast R.R. and difficulty in getting road building rock from the quarries, and the fact that a large amount of storm sewer had to be installed before any paving could be completed, the city found itself last summer with practically all its rotating fund tied up and very little money coming in from assessments.

The assessment work had been cared for by the city's regular engineering staff, in connection with its other duties. On Sept. 1, 1926, it was determined to open a separate office for the handling of assessments, the official in charge being assisted by an engineer and a stenographer, and as many typists as necessary, according to the amount of work on hand. In four months' time, the office not only released practically the entire amount of the rotating fund, but made substantial progress toward putting on a permanent basis the work of issuing assessments in the city.

Lake Worth is laid out largely on the rectangle plan, its streets, designated by the letters of the alphabet, running north and south, and the avenues, which are

TABLE I—PROGRESS BOOK RECORD FOR H ST.

Location	Clearing, Sq.Yd.	Grading, Cu.Yd.	Lime Rock Base, Sq.Yd.	Asphalt Top, Sq.Yd.
20–21	1,778	564.1	1,200	1,200
21	178	.....	164.37	164.37
21–22	1,778	596.3	1,200	1,200
22	178	.....	164.37	164.37
22–23	1,778	823.5	1,188.8	1,150
			1,189.68	1,189.68

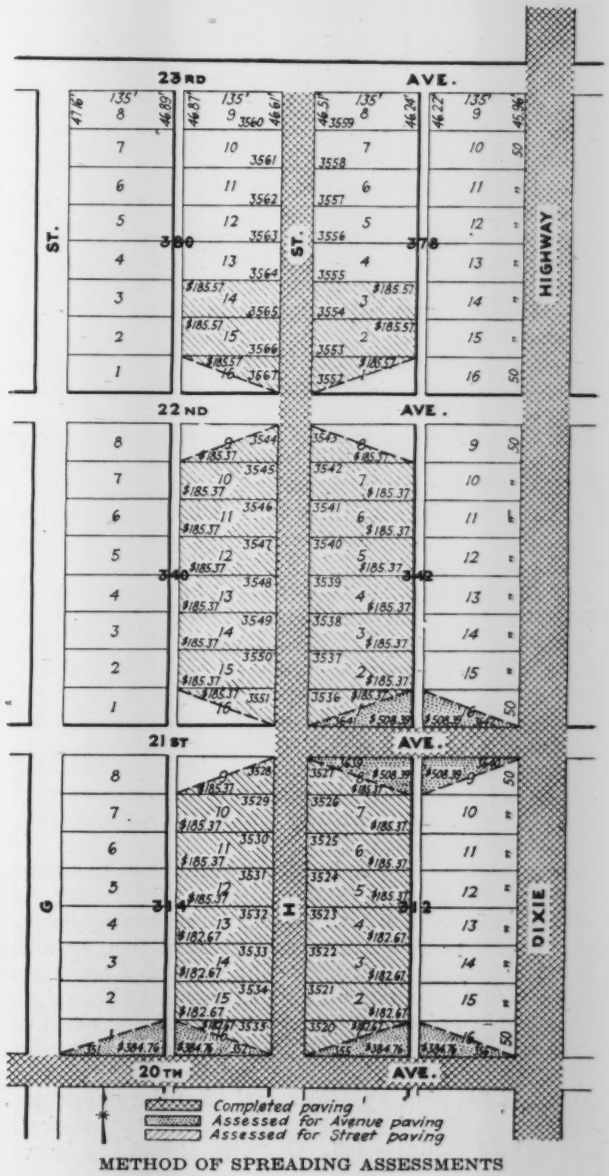
Pages 4 x 6½ in., ruled both ways.

TABLE II—H ST., 22ND AVE. TO 23RD AVE.

Lot 8, Block 378, ft.		46.51
Lot 9, Block 380, ft.		46.61
Average length of lots 8 and 9, ft.		46.56
7 lots @ 50 ft. each, ft.		350.00
Average length of pavement, ft.		396.56
(3 sq.yd. to running foot)		x3
Area of pavement (sq.yd.)		1,189.68
Area of intersections (sq.yd.)		164.37
½ area of intersection against each side of street		82.185
82.185 ÷ 396.56 sq.yd. of intersection pavement assessable per front foot		0.2072448
0.2072448 x 50 equals sq.yd. assessable against 50-ft. lot		10.36224
0.2072448 x 46.51 equals sq.yd. assessable against Lot 8		9.63895
0.2072448 x 46.61 equals sq.yd. assessable against Lot 9		9.65968

	Paving	Intersection
Lot 8	69.8025	9.63895
Lot 9	69.8775	9.65968
14 lots, 75 sq.yd. each	1,051.0000	.....
10.36224 sq.yd. each	.....	145.07136
	*1,189.68	†164.36999

* Paving checks.
† Intersection checks.



METHOD OF SPREADING ASSESSMENTS

designated by numbers, running east and west. Each block has 400 ft. of street frontage, and all lots, except in a few cases, face on the streets with a depth of 135 ft. to the service alley in the rear. The city attorney ruled that all assessments for street intersections should be apportioned equally on a front-foot basis between the lots facing on the street to the north and south as far as the middle of each block, and that each lot must be assessed for its share of street paving and intersection paving

TABLE III—H ST., 22ND AVE. TO 23RD AVE.

		Costs
Clearing, 5,675 sq.yd. @	$0.0159	$ 90.23
Grading, 1,983.90 cu.yd. @	.50	991.95
Base, 3,918.42 sq.yd. @	.85	3,330.66
Kyrock, 3,918.42 sq.yd. @	.85	3,330.66
		$7,743.50
10 per cent		774.35
		$8,517.85

	Unit Price
Grading	$0.2532
Clearing	.023
Base	.85
Top	.85

$1.9762 equals price of paving per sq.yd.

under one assessment. Each corner lot, therefore, carried an assessment for 135 ft. of paving on the avenue, for one-fourth of the intersection of the alley and the avenue, for 50 or 25 ft. of paving on its street frontage and for its share of the street and avenue intersection.

The immediate duty of the assessment bureau when first organized was to make a rapid survey of all the work which had been done, and determine where the contractor's efforts should be centered in order to release the greatest amount of assessments in the shortest possible time. It was found that a large amount of pavement had been completed which could not be assessed, due to the fact that intersections had not been finished. The intersections, in turn, were open because of the advisability of completing storm sewer manholes and pipe lines before the paving was laid. No single storm sewer system could be assessed until it was entirely completed, including all the manholes and the laterals and catch-basins draining into it. It was found, also, that construction was under way on five different sewer lines, no one of which was more than 40 per cent completed.

The bureau at once recommended the concentration of all sewer work on two lines, in order that these two might be completed at the earliest possible date. This was done, and by the middle of December over $300,000 in storm sewer assessments alone had been released. A list of all open intersections which could be completed, and all sections of rock base which could at once be surfaced and assessments thus released, was also prepared, and with this as a working schedule, to which the contractor rigidly adhered, approximately $500,000 in assessments were released in short order.

The second duty which befell the bureau was to secure the necessary materials and equipment with which to work. Little in the way of printed forms was available, and supplies of this nature had to be drawn up and printed in the greatest haste. The method in use calls for the actual preparation of the assessment bill against each individual piece of property, each bill being typed in triplicate. The original copy goes to the city clerk, who attends to the legal advertising, supplies the name and address of the property owner, and after the assessment has been advertised according to law and the required hearing held, mails the bill. One copy is kept in a loose-

TABLE IV—H ST., 22ND AVE. TO 23RD AVE.

		Distribution
20–21	1,200.00 sq.yd. @ $1.9762	$2,371.44
21	164.37 sq.yd. @ 1.9762	324.83
21–22	1,200.00 sq.yd. @ 1.9762	2,371.44
22	164.37 sq.yd. @ 1.9762	324.83
22–23	1,189.68 sq.yd. @ 1.9762	2,351.05
		$7,743.59
10 per cent		774.36
		$8,517.95

leaf binder in the assessment office as a part of its permanent records. The third copy goes to the city tax collector's office for its files.

Printed work sheets, with spaces for eight lots, or one side of a single block of 50-ft. lots, are used for "writing up" the assessments, and the typists work from these sheets in typing the bills. These sheets also form a part of the permanent records, and are filed according to street or avenue name for instant reference. Curb and gutter assessments are handled in the same way, while sewer assessments are filed by districts. Paving, sidewalk and curb and gutter assessments are placed on a front-foot basis; sewers are assessed on basis of area.

The chief duty of the bureau is to compute assessments. This work has been so arranged that it can be carried on both rapidly and accurately with a minimum of effort. The information from which all assessments are computed is taken from the progress books kept by the engineering department and made up each day from the reports of field inspectors. The figures from the progress books are first checked against the file plats of the city for accuracy, and then compared with the prices shown in the contracts, copies of which are kept in the office, to secure the actual cost of the work to the city.

H St., between 20th and 23rd Aves. (see drawing), is taken as an example. Corresponding figures from the progress book are given in Table I. These are clearing,

TABLE V—IMPROVEMENT COSTS FOR H ST., 20TH TO 21ST AVES.

Block	Lot	No.	Area, Sq.Yd.		Dollars per Sq.Yd.	Amount, Dollars	Per Cent	Total Dollars
312	1	3,520	75	Street	1.9762	148.22		
			.....	Avenue	.....	.....		
			10.273	Intersection	1.7364	17.84		
				Total		166.06	16.61	182.67
312	2	3,521	75	Street	1.9762	148.22		
			.....	Avenue	.....	.....		
			10.273	Intersection	1.7364	17.84		
				Total		166.06	16.61	182.67
312	3	3,522	75	Street	1.9762	148.22		
			.....	Avenue	.....	.....		
			10.273	Intersection	1.7364	17.84		
				Total		166.06	16.61	182.67
312	4	3,523	75	Street	1.9762	148.22		
			.....	Avenue	.....	.....		
			10.273	Intersection	1.7364	17.84		
				Total		166.06	16.61	182.67
312	5	3,524	75	Street	1.9762	148.22		
			.....	Avenue	.....	.....		
			10.273	Intersection	1.9762	20.30		
				Total		168.52	16.85	185.37
312	6	3,525	75	Street	1.9762	148.22		
			.....	Avenue	.....	.....		
			10.273	Intersection	1.9762	20.30		
				Total		168.52	16.85	185.37
312	7	3,526	75	Street	1.9762	148.22		
			.....	Avenue	.....	.....		
			10.273	Intersection	1.9762	20.30		
				Total		168.52	16.85	185.37
312	8	3,527	75	Street	1.9762	148.22		
			.....	Avenue	.....	.....		
			10.273	Intersection	1.9762	20.30		
				Total		168.52	16.85	185.37

Pages of actual form, 8½ x 11 in., ruled both ways, with double rules between entries for each lot.

lime rock base and asphalt top. In this case grading is given for both street and intersections.

As 23rd Ave. runs along a section line, all blocks between 22nd and 23rd Aves. vary from the standard length of 400 ft. This variation affects the number of front feet against which the adjoining intersections are assessed, as well as the number of square yards of pavement in the block. Each of these blocks is divided into standard 50-ft. lots, beginning at the south end, the odd distance being thrown into the last lot to the north, Lot 8 on the east side of the street, and Lot 9 on the west side. Calculation of these factors is shown by Table II, the quantities being taken from the file plats. As the pavement is 27 ft. in width the area figures exactly 3 sq.yd. to the running foot, or 1.5 sq.yd. to be assessed against each running foot on each side of the street. This example also shows the computation for the total area of the block, which has been used to correct the quantities shown from the inspector's field estimates in the progress book. This is not done where all blocks are standard.

Table III shows the third step in working up the H St. assessment. The figures from the progress book have been added, and have been multiplied by the price paid the contractors. A revision of prices was agreed upon between the city and the contractor on June 1, 1926, and all existing figures in the progress book at that time were marked over with red ink. Of the figures shown in Table I, those for clearing, grading and rock base appeared in red, indicating the prices in effect before June 1; the figures for surfacing appeared in black pencil, and indicated the "new" price of 85c. which went into effect on June 1.

With the total cost of construction determined as in Table III, the next step is to figure the price per square yard. This is done by dividing the total cost of grading by the number of square yards graded, in this case the total area, i.e., 3,918.42 sq.yd. and adding to the figure thus obtained the price per square yard for clearing, base rock and surfacing. This is checked by dividing the total cost of the paving by the total area paved. As a further check this price is then applied to each block and intersection separately, and then totaled, as in Table IV. In the case of H St. the two totals check out within 9c.; after 10 per cent for engineering, inspection, and legal expenses is added, the difference is 10 cents. To eliminate this difference would necessitate carrying the price out beyond four decimal places, which is considered close enough for practical purposes in this work.

From Table IV the work sheets are written up, as in Table V. The total of all the bills represented on the work sheets is compared with the total cost of the street, and is expected to check within a few cents. This has checked within 6c. on a total of more than $100,000, and has been as much as 4c. off on a total of $10,000, this being the widest variance that has been permitted. An adding machine slip showing the total amount of the bills is clipped to the work sheets, which are filed with the preliminary sheets as before described.

In this particular case allowance must be made for the inclusion of the north half of the intersection at 20th Ave., which is apportioned against the eight lots north thereof. The price at which the intersection is assessed was "picked up" from a preceding assessment, when H St. south of 20th Ave. was assessed. The price for the intersection figured at the time of the earlier assessment was derived as follows: Grading, $0.2364; base, 0.65; surface, 0.85; total, $1.7364.

Twentieth Ave. had previously been partly paved, hence no clearing was necessary. The price of 65c. per sq.yd. for foundation was agreed upon on a basis whereby the contractor allowed the city 20c. per sq.yd. for what rock he could salvage from the old street surface.

Allowance must also be made for the lots at the north end of H St. which will share the expense of the 23rd Ave. intersection, when that intersection is completed. The middle of the block in this case comes in lots 4 and 13, these lots paying a part of the cost of the intersection both at 22nd and 23rd Aves, while the four lots to the north of these, on either side, will be assessed for the balance of the cost of the 23rd Ave. intersection. When completed, and the cost arrived at and price determined, the price for the street paving will be picked up from this assessment as was 20th Ave. intersection price.

Of great value has been the system of maps whereby a visual record of the progress and standing of the assessments has been available at all times. For this purpose special photographic prints made directly from the file tracings, showing brown lines and lettering on a white background, and approximately 24x36 in. in size, have been used. Five sets, paving, curb and gutter, sidewalks, storm sewers and sanitary sewers, each set covering the entire city, have been made up.

As soon as the figuring of the assessments in a particular section has been completed, a serial assessment number is supplied on the work sheets against each lot. This number is then copied from the work sheets to the maps, each lot as shown on the map being marked with its individual assessment number. When this is completed the work sheets are ready for the typists. After the finished bills have been checked against the work sheets the amount of each assessment is copied directly from the bill to its appropriate place on the map. This method gives a close check against error in the description of property and the amount of the assessment, as comparative figures are always before the worker on adjacent lots while the amounts are being copied.

As each assessment is written on the map the lot to which the assessment is applied is colored yellow by brushing that portion of the map with a solution of picric acid, applied with a watercolor brush. The picric acid solution gives the required brilliance without obliterating the written figures or any other feature of the map. The finished pavement is indicated by coloring the street blue. The corner lots are divided diagonally in order to permit the writing in of two assessments, one for the avenue and one for the street.

A glance at the drawing will make this clear. The Dixie Highway, H St., 20th Ave., and 21st St. between H St. and the Dixie Highway are shown as paved. The Dixie Highway although completed, has not been assessed, neither have the five lots on either side at the north end of H St., because of the incompleted intersection at 23rd Avenue. The paving on 20th and 21st Aves. has been assessed against the abutting lots, which in the drawing have been dotted in, although in the original maps the portion of the lots which are dotted and those which are cross-hatched are uniformly colored yellow.

The maps furnish a constant and complete record of just what work has been completed, what work has been assessed, and what lots have carried the assessments. They have been of the greatest value in co-ordinating the work of the assessment bureau with the work of the city engineering department and the paving contractor, and have been particularly useful in showing inquiring property owners the equity with which the assessments are computed.

Early-Strength Concrete Patches in Paved Roads

Kansas County Repairs Opened in Three Days—Tests Show 2,600-Lb. Concrete—High Alumina and Portland Cement Both Used

By W. A. Stacey
Resident Engineer, State Highway Department, and
Reno County Engineer, Hutchinson, Kansas

FOUR years' experience with pavement construction and surface repairs which has particular reference to attempts to secure high early strength in concrete is summarized here. In all, 62 miles of pavement have been maintained during this period but the bulk of the repair work has been on 39 miles of monolithic brick built in 1919-21 without expansion joints. It has been the policy with this pavement to put in a 3-in. expansion joint at each blowout or other failure repaired. To prevent the brick from being knocked loose from the base by traffic impact at such joints, a concrete curb is brought up on both sides of the joint from the base below. Altogether the various concrete patches being made vary in number from 30 to 75 per year. Due to the fact that half the width of the pavement is always left open to traffic while a repair is being made, the amount of concrete placed in each half rebuilt usually does not exceed 1½ cu.yd.

In 1923-24, the patches were made by using local pit-run material of 3.5 to 3.75 fineness modulus mixed 1:4 loose volume for 1 min. (slump 2 in.) and opened in 7 days in hot weather. At first the patches were kept closed 10 days but it was soon discovered that they could be safely opened in 7 days. It is probable that the concrete at this age tested 2,000 lb. per sq.in. or a little better. In 1925, high alumina quick set cement patches were used with fair success for 24-hour openings of the places repaired.

In the spring of 1926, after gathering what early information was available in the technical press on attaining 3-day portland cement concrete, it was felt it would be safe to take a mix that under standard conditions would produce 4,000-lb. concrete at 28 days, and by increasing the mixing time to 5 min., gain sufficient strength to open in 3 days. After checking up on the pit-run aggregate to be used in this work, a field mix was given to the repair crew that would approximate a net water-cement ratio of 4¾ gal. to the sack of cement. The results were quite satisfactory, and several of the patches on which the barricades were destroyed by traffic at two days came through without material damage. An actual sample batch taken from the mixer on this work analyzed as follows: Fineness modulus, 3.53; mix, 1:2.33 dry and rodded or 1:3 loose volume; net water, 4.8 gal. per sack; slump, 1¾ in.; cement required, 10 sacks per cubic yard.

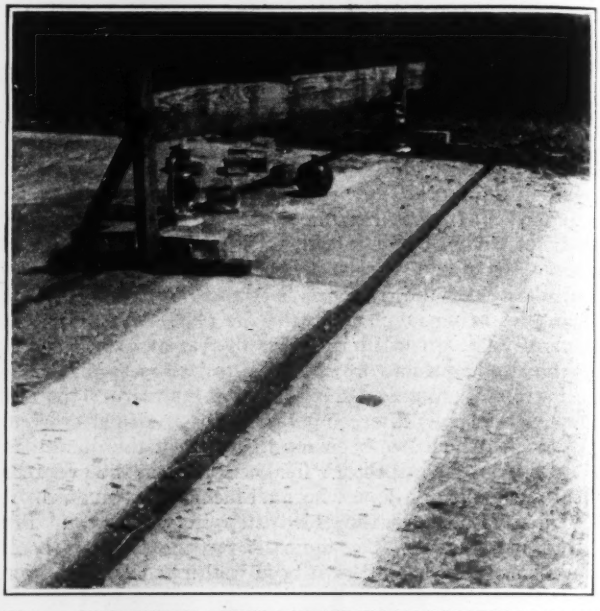


FIG. 1—EXPANSION JOINT REPAIR IN MONOLITHIC BRICK
Concrete in foreground four days old; that in background a few hours old.

According to the water-cement ratio strength law, this concrete under standard conditions should test 4,000 lb. at 28 days. From the data published by the Portland Cement Association on the effect of different mixing periods, it was estimated that a 5-min. mix would increase this 28-day strength 27½ per cent or to 5,100 lb. Using the formula $F_{28} = F_7 + 30\sqrt{F_7}$, wherein F_{28} and F_7 are 28-day and 7-day strengths, a 28-day 4,000 lb. concrete should have reached 2,500 lb. at 7 days. From the same data just referred to a 45 per cent increase in strength at 7 days was estimated for a 5-min. mix, which would raise the 2,500-lb. concrete to 3,600 lb. The actual results from ten standard 6 x 12-in. cylinders from this mix, cured at 70 deg. F. were: 3 days, 2,578 lb.; 7 days, 3,440 lb.

That it paid to use 3-day concrete instead of the previous 7-day concrete is evident, since the charge was only $1.25 for extra cement per cubic yard, against four extra days of lanterns, barricades and annoyance to the traveling public. The extra mixing time required was

FIG. 2—SEVEN-DAY CONCRETE BRIDGE APPROACH
This is the approach to the bridge on U. S. No. 50 referred to in the article.

negligible on account of the small yardage involved.

Early-strength new construction has been limited to two bridge approaches. The first, a short one, was built in 1923 by using a water-cement ratio of 4¾ gal. per sack at a 1-min. mix, curing with calcium chloride, and opening in 7 days. Though no cylinders were made from this concrete its strength should have been about 2,500 lb. at 7 days. Its condition today is satisfactory. The second was 1,300 sq.yd. of one-course concrete placed in April, 1927, on US—50 highway four miles west of Hutchinson where the traffic average is 2,000 vehicles per day. Originally contracted for on the basis of 1:2:3½ concrete, a special agreement was later made with the contractor to substitute 7-day concrete and build one side of the slab at a time in order to maintain traffic without detouring.

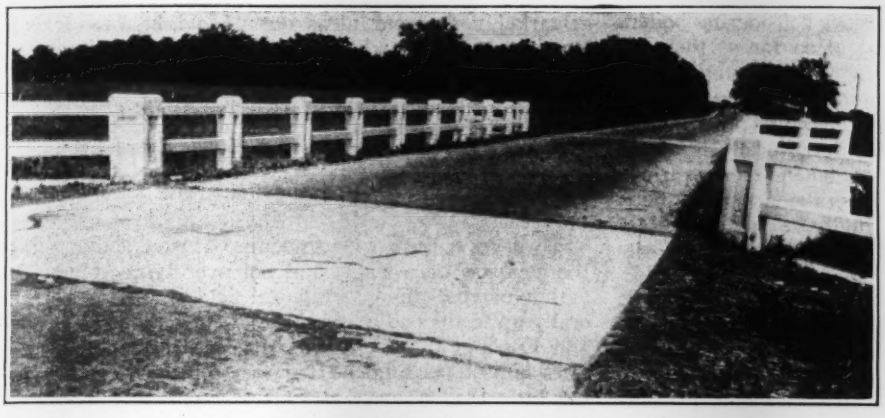


FIG. 3—PATCH IN BRICK PAVEMENT BRIDGE APPROACH

The old pavement had sunk 1½ to 2 in. The 3-in. brick top was removed and 3-day concrete placed on the old base to restore riding smoothness. Job 4 months old.

On account of the small size of his mixer, the contractor did not wish to increase the mixing time. Therefore, it was decided to set up a mix which would approximate 3,000 lb. at 7 days or 4,500 lb. at 28 days under standard conditions. From the fineness modulus and bulking tests on the aggregates at hand, the mix for the field was set as 1:1.85:2. This may look unbalanced but the sand was coarse. The water content was controlled by holding to a uniform slump as indicated by the standard 4 x 8 x 12-in. cone.

Of six cylinders taken on this job, three were tested at 7 days and three at 28 days, and their averages were 2,925 lb. and 4,733 lb. respectively. The increase in the amount of cement used per cubic yard over the standard 1:2:3½ mix of the contract was 0.40 bbl. The resultant pavement carried traffic after 7 days very satisfactorily.

Portland Building Failure Due to Splice of Wooden Truss

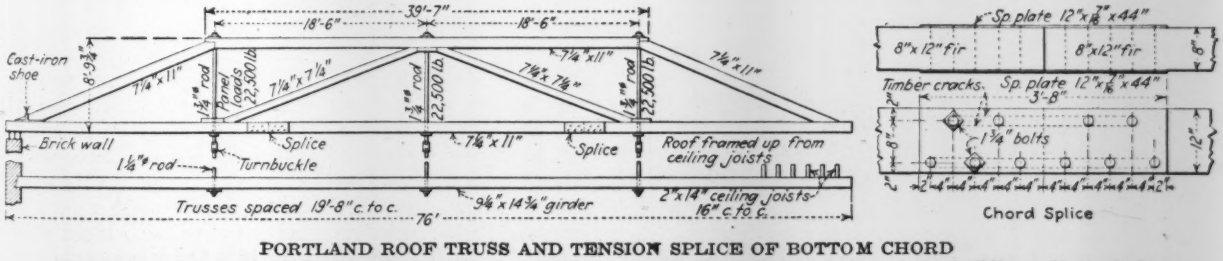
FAILURE of the tension splices in a wooden roof truss is given as the cause of the collapse of a building under reconstruction in Portland, Ore., on July 23, in a report on the accident recently rendered by H. E. Plummer, city building inspector. The building was an old two-story structure with brick walls, which nine years ago was reconstructed by removing several bearing partitions in the second story and replacing them by wooden girders hung from wooden trusses placed above the roof.

The bottom-chord splices of these wooden trusses were made of two steel plates 12x$\frac{7}{16}$-in. by 44 in., one on either side of the chord, bolted through with 10 ¾-in. bolts, in two rows, spaced 8 in. The trusses were also completely inclosed in galvanized sheet-iron covering, to protect them from the weather.

Examination of the wreckage showed that the splices of one truss had failed by shearing of the wood between the bolts, and that the resulting sagging of the truss had pushed out the walls and allowed the roof to fall on the second floor, breaking this down in part. Upon examining the splices in the bottom chords of the other roof trusses, it was found that similar shearing failure had started in six out of nine splices examined. The truss timbers also showed much lateral shrinkage.

Mr. Plummer reports that the splices had a calculated capacity of 78,000 lb. tensile stress, while the actual stress in the chord at the time of the failure was only 27,600 lb.

The conclusions of the report are that the use of green timber in trusses is not desirable, that splices in tension members of wooden trusses should be avoided if possible, that the use of steel splice plates on the sides of green timber is dangerous, and that the accident raises question regarding the strength and sufficiency of other timber trusses throughout the city and points out the desirability of making a general inspection of wooden trusses.



PORTLAND ROOF TRUSS AND TENSION SPLICE OF BOTTOM CHORD

The timber sizes in the truss drawing, which are roughly approximate actual sizes, indicate considerable shrinkage. A building under reconstruction in Portland had a number of roof trusses of this design. One truss failed on July 23, causing the collapse of part of the building. Most of the splices in the other trusses showed shear cracks between the bolt holes as indicated by dotted lines in the splice sketch.

Engineering Literature

A Monthly Review of Books and a Listing of New Publications

Boiler Feed Waters and Accessories

REVIEWED BY ROBERT SPURR WESTON
Consulting Sanitary Engineer, Boston, Mass.

BOILER FEED WATER PURIFICATION—By Sheppard T. Powell, M.Am.Inst.Chem.E., M.Am.Chem.Soc., M.Am.W.W. Assoc.; Consulting Chemical Engineer. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. 363; 8 plates and 150 text illustrations; 24 tables. $4.

A broader field than the title indicates is covered by this book which takes up nearly everything known about waters used for steam making besides considering boilers and other power-plant equipment in so far as they are affected by or are used to treat boiler waters. The author is a chemical engineer familiar with power-plant practice and well known to engineering practitioners in the field of water supply. While naturally much of the information in the book is taken from various sources, it abounds in examples from the author's experience and while the geographical limits of these examples are somewhat limited, they impart a freshness of treatment unusual in a book of this type.

Natural waters and their impurities are clearly described, as well as the losses due to scaling, corrosion and embrittlement. Then follow the methods used to correct poor waters. Among these are sedimentation, coagulation, filtration, softening by various processes, evaporation, boiler compounds, deconcentration, deaeration, blowing, electrolytic treatment, etc. The chapters on coagulation and filtration are well written and illustrated by modern devices. The chapters on softening include both treatment by lime, soda, barium, sodium aluminate and other chemicals and also treatment by zeolytes, artificial and natural.

Evaporators are well described and numerous examples of foreign machines are shown and commented upon. The author bears in mind that evaporators are but complicated boilers subject to water troubles and gives directions for avoiding scaling and corrosion therein. Deaeration and its effect in preventing corrosion are given considerable space and the necessity for the practice of deaeration in power-house practice is well set forth. Deconcentrators and blow-down systems, many of which have been of recent origin, are well described and the efficiency of performance well discussed. The chapter on boiler compounds does much to elucidate these expensive expedients, whose advantages and disadvantages are set forth.

Nowhere is there a better summary of the literature on priming and foaming than in the chapter with that heading. The illustrations and descriptions of steam purifiers in this chapter are typical of the best practice. The chapter on feed water heaters, their uses and types, on filters and on water treatment by electrolysis contains much valuable information and excellent opinions regarding the efficacy of devices and methods. Included in the book are standard methods of analysis as well as useful tables and blank forms for plant records. Perhaps the most valuable parts of the book are the unusually complete bibliographies, one of which ends each chapter. A collection of the publications thus listed would form an excellent library of the art.

In trying to write for the untechnical reader the author has mixed terms somewhat—e.g. carbonate of calcium and calcium carbonate; one or the other, preferably the latter, would be better. The reviewer would prefer more frequent use of parts per million or pounds per million gallons in place of grains per gallon, a cumbersome term apparently necessary in boiler water practice.

The book is timely, fresh in its treatment and contains remarkably few old ideas out of old books. It is a worthy production which will prove to be widely useful.

Evolution of the Architect

THE ARCHITECT IN HISTORY—By Martin S. Briggs, F.R.I.B.A. Oxford (England): Oxford University Press. Cloth; 6x8 in.; pp. 400; 46 illustrations—frontispiece, portraits, other halftones, drawings. $3.75 from Oxford University Press, American Branch, New York City.

To bring a book with so comprehensive a title within the compass of a single and not over large volume the author narrows his geographical field from Europe generally up to the end of the Middle Ages, to Italy, France and England for the Renaissance period, and then confines himself to England from the nineteen century and the little that he says about the twentieth. The main object of the author is "to claim for the architect the position in history that is his due, and to expose prevailing fallacies about his work where substantial evidence or reasonable inference permits." Would that the same attempt might be made, and as ably effected, for the engineer!

The opening chapter, The First Architects, goes a bit beyond Europe, with brief references to Egypt, Babylonia and Chaldea, besides a few paragraphs on architects and architecture in general. Here, and also in what follows down through the Middle Ages, it is difficult to trace the position of the architect. Specific mention of him is so infrequent that many have assumed he did not exist and that hundreds of architectural monuments, including some of the greatest cathedrals, were mass creations of all the artisans engaged on them, directed only by the art and crafts spirit of the time. This is one of the fallacies the author takes pleasure in exposing, partly by scanty and sometimes obscure records and largely on a sort of practical rule of reason, to the effect that constant planning by a single directing mind was essential to the orderly carrying out of such large structures. Some of the early architects, it appears, were almost if not quite as much engineers as architects, and often the practice of these two arts was combined with that of painting or sculpture, if not both.

Much attention is given to the training of architects, especially in and since the Renaissance, as also to their compensation. The evolution of the apprentice system, followed by the rise of schools, is brought out.

Altogether the book is interesting and stimulating. As already intimated, it suggests the need for a similar study of the engineer in history, including his position in the world of today.

Mathematics for Modern Engineers

REVIEWED BY G. PAASWELL
Engineer, Corson Construction Corporation,
Brooklyn Borough, New York City

THE MATHEMATICS OF ENGINEERING—By Ralph E. Root, Ph.D., Professor of Mathematics and Mechanics, Post Graduate School, United States Naval Academy. Baltimore, Md.: The Williams and Wilkins Co. Cloth; 6x9 in.; pp. 540; 115 line drawings. $7.50.

Professor Root's book has been written with the two-fold object of giving a thorough mathematical training to students in the various engineering professions and meeting the mathematical requirements of the modern engineer. The author does well to note the word modern, since a perusal of recent papers in the proceedings of the technical societies brings to the fore the increasing use of all the branches of mathematical analysis.

The text is unusually easy to follow, is thorough in its treatment and is well subdivided for the needs of the engineer. Starting with the usual definitions, it takes the reader through the elementary treatment of the usual function types; the solution of equations; the differential and integral calculus and differential equations. There is an adequate treatment of the theory of probability and its relation to the study of empirical equations and plotting.

There is some matter on the subject of series, harmonic and periodic forms and the imaginary form. The author makes contact frequently with problems of a practical nature. The young engineer keen to enter the fields of research and yet weak in mathematical training, will find that a year's study of this book will give him a powerful tool.

As is usually the case, one overlooks the many valuable topics covered, and emphasizes rather the omissions. Thus the reviewer regrets to see nothing on that important topic, vector analysis; on the applications of the complex variable to conformal representation, especially in connection with the theory of elasticity and allied topics as well as mapping; on the subject of frequency curves, which have such chaotic treatment in engineering papers; on the highly important forms of differential equations of the second order which occur in the study of elasticity, hydrodynamics and aerodynamics; and on the practical solution of elliptic and hyperbolic functions which appear in so many problems of calculation. Again, he fails to see the complete treatment of the cubic equation. Few engineers realize that the cubic equations which appear in their work can all be completely solved by either circular or hyperbolic functions.

However, these omissions are not as serious as they sound, and to the reader who has made good use of this text the omissions may easily be supplied by a study of the reference texts quoted in the book.

Indeterminate Franchises

THE INDETERMINATE PERMIT in Relation to Home Rule and Municipal Ownership, A Report Prepared for the Public Ownership League of America—By Delos F. Wilcox, Ph.D., Consulting Franchise and Public Utility Expert, sometime Chief of the Bureau of Franchises of the Public Service Commission for the First District, New York, sometime Deputy Commissioner of the Department of Water Supply, Gas and Electricity of the City of New York, Author of "Municipal Franchises," "Analysis of the Electric Railway Problem," etc. Chicago, Ill.: Public Ownership League of America. Paper; 6x9 in.; pp. 99. $2.

The history of the indeterminate permit or franchise in Wisconsin, Massachusetts, Indiana, a number of other states and a few cities is succinctly reviewed in this pamphlet—from the viewpoint of an advocate of municipal home rule and municipal ownership. Apparently the author was in favor of the indeterminate permit at the outset, but in common with others who looked upon it as paving the way for municipal ownership, he seems to have become disillusioned. He says in his introduction: "The indeterminate permit, where it has been used on a large scale, has proven to be perpetual and exclusive, but not altogether dependent upon the good behavior of its owners. Where it has been drafted in such form as to give substantial guarantees of good behavior, the utilities do not care for it." Among the general chapters following the historical review, mention may be made of Where Publicity of Accounts Has Broken Down, Where State Regulation Has Broken Down, Where the Right to Terminate the Permit Breaks Down. There are no dull pages in the pamphlet for any one interested in street railways, municipal home rule, or municipal ownership.

Excavation, Performance and Costs

METHODS AND PLANT FOR EXCAVATION AND EMBANKMENT—By Charles H. Paul, Consulting Engineer, and Charles S. Bennett, Engineer, the Miami Conservancy District. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 328; 109 halftones and line cuts. $4.

Based on the extensive records of excavating machinery performance and costs kept by the engineers of the Miami Conservancy District, the authors, both of whom were members of the district's construction forces, have produced a volume on earth and rock excavation which is notable for the amount and precision of the original data presented. In addition to analysis and summation of the district's records, the authors have searched other records, and particularly those of the U. S. Reclamation Service, for figures of a corresponding kind to round out the measure where it was not filled by the operations for flood protection in the Miami River valley. The number and variety of these operations, however, embraced so many kinds of open-pit excavations and earth-embankment construction that few journeys afield were necessary to cover the whole range of earth and rock moving operations. The book, therefore, is a compilation and appraisal of data more truly original with and personal to the authors than are those in most engineering books.

Beginning with scraper and elevating grader work, the authors take up power shovel work, dragline excavator work, cableway and power scraper work, hydraulic sluicing, dredging and transportation of excavated material. The chapter on dragline excavator work is the great chapter in this part of the book. The data given are without doubt the most comprehensive and detailed that can be found in one place anywhere in print. Next in value are the chapters on hydraulic sluicing and on power-shovel work.

In the section of the book devoted to embankment construction there are four main chapters, discussing levee and roadbed embankment, rolled embankment, hydraulic fill and semi-hydraulic fill. Like the chapter on dragline excavator work in the first part of the book, there stands out in this part, because of its breadth and detail, the chapter on hydraulic fill. The hydraulic fill dam work of the Miami Conservancy District contributed heavily to engineering knowledge of this method of construction and all the story and all of the records are given in the authors' discussion.

Primarily this book is a notable contribution of performance data and cost records. Its descriptions of ma-

chines and processes are merely supplementary, although of course highly necessary, to the figures of outputs and costs. The authors have done well in the way of illustration and have furnished an adequate index.

Highway Handbook Rewritten and Enlarged

HANDBOOK FOR HIGHWAY ENGINEERS, Containing Information Ordinarily Used in the Design and Construction of Rural Highways—By Wilson G. Harger, C.E., and Edmund A. Bonney, formerly Supervising Engineer, New York State Department of Highways. New York and London: McGraw-Hill Book Co., Inc. Flexible; 4x7 in.; pp. 1753; 360 line cuts; tables. $6.

Successive editions of this well-known handbook have made road builders familiar with its general plan and contents: first, a discussion of general principles of economies and design; and second, a concise collection of data ordinarily required for everyday work. In this fourth edition, the author announces that all the text has been rewritten and some 700 pages added.

Student Notebook

ENGINEERING PROBLEMS MANUAL—By Forest C. Dana, Professor of Engineering Problems, and Elmer H. Willmarth, Associate Professor of Engineering Problems, Iowa State College. New York and London: McGraw-Hill Book Co., Inc. Cloth; 5x7½ in.; pp. 187; illustrated. $2.

Prepared for use in connection with courses given by the authors at Iowa State College, this book is not a text on mathematics, physics or chemistry but rather a student notebook covering the work offered. Solving problems is not the sole purpose of the course as considerable attention is paid to neatness, clearness, system and to developing the student's knowledge of basic engineering principles. Practical engineering problems are co-ordinated with the work given in the course in algebra, trigonometry and calculus.

Painstakingly and Clearly Written

MECHANICS OF MATERIALS—By George Young, Jr., Professor of Architecture, Cornell University; and Hubert Eugene Baxter, Assistant Professor of Architecture, Cornell University. [Engineering Science Series.] New York: The Macmillan Co. Cloth; 6x9 in.; pp. 451; 457 line cuts. $4.

Somewhat departing from the usual scope of the title, "Mechanics of Materials," the authors have here introduced several chapters on pure mechanics, covering the equilibrium of forces, determination of center of gravity and the like. Their subsequent chapters on stresses, beams, columns and some miscellaneous matters are thoroughly elementary in the sense of what most college engineering courses cover, but they have the merit of being painstakingly and clearly written.

Valuation of Real Estate

PRINCIPLES OF REAL ESTATE APPRAISING—By John A. Zangerle. Second Edition. Cleveland, Ohio: The Stanley McMichael Publishing Organization (Realty Building, 1222 Prospect Ave,). Cloth; 6x9 in.; pp. 443; illustrated; tables. $5.

From a small beginning in 1917 and subsequent changes and enlargements, the author brought out in 1924 what he terms the first edition of this book. The present ("second") edition has been extensively revised and has also been enlarged by some 90 pp. The author who is a lawyer, has acknowledged his assistance from John Warner, an architect, who, the author states, "has worked untiringly in bringing all building appraisal data up to date." Among the chapter headings are: What Is Value?; Appraisals on Pedestrian Counts, Earnings, Rentals and Building Permits; the Unit Foot Appraisal Method; Corner Lot Appraisals; Manufacturing and Railroad Property; Advantages of Standardized Assessments; Special Assessment Methods; Obsolescence; and Local Labor and Material Costs as Affecting Prices. A new chapter is entitled "Legal Decisions Regarding Appraisals." The book contains a few tables and diagrams, but not as many as might be expected. An interesting feature of the book is a series of halftones of various kinds of buildings with schedule classifications and reproduction cost factors below.

Publications Received

ZONING PROGRESS IN THE UNITED STATES, both as regards legal decisions and the adoption of zoning ordinances, is set forth in a mimeographed bulletin of the U. S. Department of Commerce (Washington, D. C.) which is in effect a revision of previous bulletins on the subject.

A REPORT on the projected water-supply aqueduct for Santiago, Cuba, has been made by the Secretary of Public Works and is now available as a 230-p. pamphlet in which are described the various projects since the Acueducto Nuevo was proposed in 1908, and the more important laws and correspondence bearing on the subject. (Secretaria De Obras Publicas, Havana, Cuba.)

THE LATEST BULLETIN (June) of the Seismological Society of America (Stanford University, Calif.; 75c.) contains not only the proceedings of the last annual meeting of the society but also two papers of engineering interest: Earthquakeproof Construction by Tachu Naito and Seismic Measurements by the Overthrow of Columns, by Paul Kirkpatrick. The secretary of the society is Dr. S. D. Townley, Stanford University.

LITERATURE on the Constitution of Portland Cement Concrete, Digested by R. H. Bogue, and published in *Concrete* during 1926-27, has been reprinted as paper No. 3 of the Portland Cement Association Fellowship at the U. S. Bureau of Standards (Portland Cement Association, Chicago, Ill.) The descriptive text is followed by a bibliography beginning with Vitruvius and continuing with references down to 1925.

L'INGEGNERE, a new Italian monthly technical journal, issued its original number in July. It is the organ of the fascist federation of engineers (Sindicato nazionale fascista ingegneri), a group of some 11,000 engineers, it is said. Its scope is to cover the entire engineering field. Civil-engineering matters predominate in the first three issues, but a few articles in the field of minerals separation, architecture and power generation represent the other parts of the field.

A PUMP HANDBOOK has been published by Worthington Pump & Machinery Corporation, New York City ($3). Primarily it is a 500-p. book on Worthington pumps but is written from a general viewpoint, making it, as the company hopes, "worthy of a place in the reference library of any engineer, student or user of mechanical equipment." The main topics are general theory, centrifugal pumps, power pumps, deep-well pumps, power for pump drives, direct-acting steam pumps, installing and operating Worthington pumps and machinery, pumping in the petroleum industry. There are 35 pp. of tabulated data.

THE FLOODS OF THIS YEAR give renewed interest to a paper on Forests and Water in the Light of Scientific Investigations, by Raphael Zon of the U. S. Forest Service, now reprinted from the final report of the National Waterways Commission (1912) with the bibliography revised to June, 1927. One of the conclusions of the 1912 report that apparently still holds good in the author's mind is: "Floods which are produced by exceptional meteorological conditions cannot be prevented by forests, but without their mitigating influence the floods are more severe and destructive." (20c. from Superintendent of Documents, Washington, D. C.)

HANDBOOK OF CAST-IRON PIPE, just published by the Cast Iron Pipe Research Association, Chicago, Ill., contains 335 pp. of information on cast-iron pipe. It includes the stand-

ard specifications and tables of both the American Water Works Association and the American Gas Association; also specifications and tables for cast-iron pipe joints and for standard flanged pipe. In addition there are descriptions of the production of iron and of cast-iron pipe, chapters on pipe laying, cement-lined iron pipe, substitutes for cast-iron pipe, flow tables, and electrolysis. (Free to applicants likely to make good use of the book.)

OVER A MILLION PEOPLE are tributary to the sewage collection and treatment works of the Birmingham, Tame & Rea District Drainage Board, which recently celebrated the conclusion of the first half century of its existence. A handsome illustrated pamphlet of 97 pp. in honor of the event has been published. It contains a History of the Board by Arnold E. Harris, clerk to the board (Birmingham, England), a description of the works by H. C. Whitehead, engineer to the board, and a Foreword by Neville Chamberlin, Minister of Health and son of the late Joseph Chamberlin, mayor of Birmingham, when the board was formed. Among the many portraits contained in the booklet is one of John D. Watson, engineer to the board from 1899 to 1924.

THE PUNJAB ENGINEERING CONGRESS of 1927 is reported in a pamphlet of some 120 pp. which includes papers and discussions on not only irrigation subjects, but also roads, cement and mortar. There is also a brief description of the organization of the Government School of Engineering, at Rasul, Punjab, where instruction is given in irrigation, railways, sanitation and other civil engineering subjects. The pamphlet contains papers on "Interlocked Adjustable Module of Precast Reinforced-Concrete Units"; "Outlet Adjustable Proportional Modules"; "Principles of Design of Dissipator Below a Fall," and other subjects. The business manager of the Congress is David A. Howell, and the secretary is James H. Johnson, both associate members of the Institution of Civil Engineers, presumably located at Lahore, Punjab.

A NEW JOURNAL of the iron and steel industry has made its appearance in Germany, under the title *Archiv für das Eisenhüttenwesen*. It is an official publication of the Verein deutcher Eisenhüttenleute at Düsseldorf, and nominally is a monthly supplement to the long-established weekly journal, *Stahl und Eisen*. The initial number appeared in July. From the contents tables of the first few issues it appears that the journal will cover quite broadly the field indicated by its title. Subjects range from coal study and gas producer operations to ore preparation on the one hand, and operating problems of blast furnaces, open hearth plants and rolling mills on the other, including matters of chemistry and testing. Both in the caliber of its contents and in its mechanical production it is evidently of first rank, which forecasts a useful existence.

PLANNING FOR CITY TRAFFIC, a symposium under some 30 heads with as many authors, edited by Austin F. Macdonald of the University of Pennsylvania, occupies 249 pp. (nearly the entire space) of the September *Annals* of the American Academy of Political and Social Science ($2 from Editorial Office, 3622 Locust St., Philadelphia). The separate papers are grouped under five main heads: (1) Planning for Increased Traffic Facilities; (2) Traffic Control; (3) Planning to Prevent Traffic Accidents; (4) Traffic Regulation; (5) Traffic Problems and the Modern City Plan; (6) City Planning and Traffic Congestion. Among the dozen engineer contributors are Harold M. Lewis, executive engineer, Regional Plan of New York and Its Environs, who writes on routing through traffic; O. S. Haas, illuminating engineer, National Lamp Works of the General Electric Co., on planning the street lighting system; Ole Singstad, chief engineer of the Holland Tunnel, on relation of tunnels and bridges to traffic congestion; Fred Lavis, consulting engineer, New York City, on grade crossings; and E. P. Goodrich, consulting engineer, New York City, on zoning and its relation to traffic congestion. Almost every conceivable angle and viewpoint of the main subject is reflected. The symposium should be of wide interest and great value to the rapidly growing number of people who in a variety of ways are concerned with the city traffic and planning.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

ANALYSIS OF CONCRETE ARCHES—By W. P. Linton, Highway Bridge Engineer, and C. D. Geisler, Assistant Highway Bridge Engineer, U. S. Bureau of Public Roads. Reprinted from *Public Roads*, June and July, 1927. Paper; 9x12 in.; pp. 24. (10c. from Superintendent of Documents, Washington, D. C.)

A. S. T. M. TENTATIVE STANDARDS, 1927—Compiled and Published by American Society for Testing Materials. Philadelphia, Pa. Cloth or paper; 6x9 in.; pp. 824; line cuts, halftones, charts. Cloth, $8, paper, $7.

CONSTRUCTIONAL STEELWORK SIMPLY EXPLAINED—By Oscar Faber, O.B.E., D.Sc., M.Inst.C.E., V.P.Inst.Struct.E., Consulting Engineer to H.M. Office of Works, Bank of England Rebuilding, etc. Author of "Reinforced Concrete Simply Explained," etc. New York: Oxford University Press, American Branch. Cloth; 6x9 in.; pp. 120; 54 line cuts. $2.

A small British book gives a non-mathematical and very plainly written introduction to the design of steelwork. It concerns itself with beam and column proportioning, connections of members and bases. Beginners will find it of help in giving them a clear understanding of some of the initial difficulties of steel design.

CORRESPONDENCE Between H. Weston and Ministry of Transport on Relative Value of Mild Steel and High Tensile Steel in Reinforced Concrete Construction. Reports thereon by David Kirkaldy & Son, Oscar Faber, D.Sc., M.Inst.C.E., Considère Constructions, Ltd., G. Topham Forrest, F.H.I.B.A., Superintending Architect, London County Council. Paper; 5x8 in.; pp. 19. Apply to Weston Concrete Engineering Co., Ltd., 2 Dean Farrar St., Victoria St., Westminster (England), S.W. 1.

THE DESIGN AND CONSTRUCTION OF DAMS: Including Masonry, Earth, Rock-Fill, Timber and Steel Structures, Also the Principal Types of Movable Dams—By Edward Wegmann, C.E., M.Am.Soc.C.E., Consulting Engineer, New York, Author of "The Water Supply of the City of New York, 1658-1895," "The Conveyance and Distribution of Water for Water Supply." With a Mathematical Discussion and Description of Multiple Arch Dams—By Fred A. Noetzli, D.Sc., M.Am.Soc.C.E., Consulting Engineer, Los Angeles, Calif. Eighth Edition, Revised and Enlarged. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. Cloth; 10x12 in.; pp. 740; 273 halftones and line cuts in text, 50 inset halftone and line cut plates, 91 large plates of drawings of designs of dams; bibliography, index. $17.50.

DISPOSAL OF SUGAR FACTORY WASTES, With Introductory Remarks on Water Legislation—Written by Prof. Ing.-Dr. Jaroslav Cerny, translated by Ing.-Dr. Vaclav Dasek. [Booklets of the Ministry of Agriculture, No. 68. Edited by Dr.-Ing. Ed. Reich.] Prague (Czechoslovakia): Ministry of Agriculture. Paper; 5x8 in.; pp. 21. 4.5 kr.

Review of sugar factory water treatment and of legislation on stream pollution by various countries.

FRICTION OF WATER IN ELBOWS—By F. E. Giesecke, C. P. Reming, and J. W. Knudson, Jr. [University of Texas Bulletin 2712; Engineering Research Series, No. 22.] Austin, Texas: University of Texas. Paper; 6x9 in.; pp. 36; 15 line cuts and halftones.

THE MICROSCOPY OF DRINKING WATER — By George Chandler Whipple, Late Gordon McKay Professor of Sanitary Engineering, Harvard University; Revised by Gordon Maskew Fair, Assistant Professor of Sanitary Engineering, and Melville Conley Whipple, Assistant Professor of Sanitary Chemistry, both of Harvard University. Fourth Edition, Rewritten and Enlarged. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. Cloth; 6x10 in.; pp. 586; 123 line cuts and halftones, 7 plates in text and 19 colored plates, with descriptions at end of book. $7.

PROPERTIES OF MATERIALS AT HIGH TEMPERATURES, II: Mechanical Properties of 0.51 per cent Carbon Steel and 0.53 per cent Carbon Cast Steel—By H. J. Tapsell, A.C.G.I., and W. J. Clenshaw. [Engineering Research Special Report No. 2, Department of Scientific and Industrial Research.] London (England): H. M. Stationery Office. Paper; 6x9 in.; pp. 16; 8 line cuts.

The report, Properties of Materials at High Temperatures, I, on the mechanical properties of Armco Iron, 0.17 per cent carbon steel and 0.24 per cent carbon steel, was published as Engineering Research Special Report No. 1 last May. The work for the two reports has been carried out at the National Physical Laboratory, Westminster.

SURFACE WATER SUPPLY OF HAWAII, July 1, 1922, to June 30, 1923—Nathan C. Grover, Chief Hydraulic Engineer; E. D. Burchard, District Engineer. Prepared in co-operation with the Territory of Hawaii. [Water Supply Paper 575, Department of the Interior, Hubert Work, Secretary, U. S. Geological Survey, George Otis Smith, Director.] Paper; 6x9 in.; pp. 173. (25c. from Superintendent Documents, Washington, D. C.)

TIDAL DATUM PLANES—By H. A. Marmer, Assistant Chief, Division of Tides and Currents, U. S. Coast and Geodetic Survey. Paper; 6x9 in.; pp. 142; 52 charts. (30c. from Superintendent of Documents, Washington, D. C.)

A "working manual for the determination of the more important tidal datum planes," with a "discussion of the principles involved and accuracy obtainable."

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Government to Begin Flood Study

[Ten days ago, when it became clear that New England had been swept by a storm of unprecedented magnitude, "Engineering News-Record" addressed the Secretary of the Interior to urge that comprehensive study of flood contingencies be begun as quickly as possible. In reply the Hon. Hubert Work states that study of the New England flood is already under way, and indicates that broader study of floods will also be undertaken. The letters follow. Some remarks on them will be found in the editorial pages of this issue.—EDITOR.]

Sir—In view of the disastrous and almost unprecedented flood in the upper New England States, we take the liberty of bringing to your attention the serious situation that has existed or been recognized to exist for half a dozen years or more, in respect to the urgent need of comprehensive study of flood data and their analysis in terms of flood dangers for different streams. Such study and analysis appear to be beyond the powers of any private or local agency, and to fall quite naturally into the great field covered by your department.

Each of the local flood disasters that in recent years have visited one or another section of the country and formed the outstanding feature of the day's news two or three times a year, revealed the fact that the flood risks of the streams concerned were not known to the people living along their banks, or else these risks were misunderstood. Both these unfortunate conditions would be eliminated by adequate collection of flood flow data and their competent analysis.

Many engineers have been seriously concerned about this lack of knowledge of flood facts, for a number of years. Five or six years ago the American Society of Civil Engineers organized a special committee to collect and study such data. It soon found, however, that the task was of a magnitude far beyond the powers of private investigators, even through the medium of a large engineering society, and the work therefore waits and will probably continue to wait, until a competent national agency takes it up.

We feel that if you realized the pressing importance of this situation as fully as it deserves, you might be able to find a way for a prompt beginning on such a study by one of the capable agencies of your department, for example, the Geological Survey. We believe also that it will be readily possible to convince Congress of the need for a suitable appropriation to continue the work and carry it to a conclusion.

New York, N. Y., ENGINEERING NEWS-RECORD.
Nov. 7, 1927.

Sir—I have considered with much interest your letter of Nov. 7 relative to the recent unprecedented floods in New England and the necessity for collecting systematic records of facts relating to floods.

I assure you of my appreciation of the absolute necessity of possessing reliable data with respect to flood discharges as a basis for engineering designs and specifications to be made for many purposes and in the interest of wise, safe, and orderly development and utilization by the general public of rivers and river valleys.

In order that the essential facts relating to the recent flood in New England may be recorded and published in form for use by engineers, instructions were immediately issued to H. B. Kinnison, the District Engineer of the Geological Survey, with headquarters in Boston, for the early preparation of a report and he has already begun work in the collection of the essential facts. That such a report will be of great interest and value is indicated by the fact that, since those instructions were issued, application has been received from Vermont for the preparation of such a report and many engineers in New England, who are using or are interested in its rivers, have offered their co-operation in the collection of data. This is in line with your own suggestion.

I can assure you, therefore, that this Department, acting through the Geological Survey, is endeavoring to serve the needs of the people as best it may with the funds and personnel available in collecting and publishing the facts relating to recent floods. I regret that the available funds are not sufficient for all the work that should be done. I have joined with the Secretaries of War and Agriculture (constituting the Federal Power Commission) in approving a Bill, H. R. 9397, introduced in the last Congress by Representative Newton of Minnesota, which, if enacted, will provide increased funds for use by the Geological Survey in this Department in studying the water resources of the country, a study which of course would include the flood stages. It would seem that the engineering press and engineering societies may best serve the ends which you are seeking, by actively supporting this bill which I assume will be reintroduced in the Congress which will convene in December.

Washington, D. C., HUBERT WORK,
Nov. 10, 1927. Secretary, Department of the Interior.

Flood Study and Flood Precautions

Sir—So far as our Factory Mutual field engineers have yet secured data from the New England flood region, the depth of rain was decidedly smaller than in the great New England storm of 1869 (see James B. Francis "The Distribution of Rainfall During the Great Storm of Oct. 3-4, 1869," *Trans. Am. Soc. C.E.*, 1878, p. 224). It was also less than that over the Miami Valley in 1913. [This appears questionable, as the Miami 3-day total for a 4,000-mile area was 6.04 in., as reported in *Engineering News* of Jan. 4, 1917, p. 13, while Prof. Barrows in the present issue reports a two-day total of nearly 7 in. for a corresponding area.—EDITOR.]

I have just written to the governor of Rhode Island urging the need of a flood survey of the dams and water channels of the state, and stating emphatically that the possibilities of disaster of this kind can always be foretold to the extent of saying that:

(1) Anywhere in this part of the United States we are liable to a precipitation of 10 in. over an area as great as 10,000 sq.miles.

(2) On small drainage areas, spillways should be designed to pass at the rate of 6 in. depth of runoff uniformly within 24 hours (this was the rule worked out by James B. Francis many years ago for the Boston water-works).

(3) On larger watersheds an experienced engineer should have available ample data for showing what may happen say once in two or three centuries on watersheds of various areas and declivities, and in the light of these data could say how much should be provided for at any given locality along the stream.

(4) The next question is to estimate spillway capacities over dams and channel capacities through crowded residential districts, and see how high the water would rise or how fast it would tear along with a flood flow of this volume.

The best treatise on these matters ever yet written was that worked out by the engineers of the Miami Conservancy District after the great flood of 1913.

About 50 years ago under Hiram F. Mills, along with Edwin A. Fisher, for many years city engineer of Rochester, N. Y., I helped work out the problems of a flood protection dike for the city of Westfield, Mass., and if I am correctly informed this dike of 50 years ago measured up its responsibilities during the recent flood, although within a district where there was much damage. The classical instance of foresight is that of James B. Francis, who built "Francis's Folly" (so-called) at the head of the canal in Lowell, comprising a high dike and an enormous emergency gate hung by an iron strap which could be cut with a cold chisel in time of great emergency, letting the gate fall. This was ridiculed for ten years more or less, and then the flood came. The gate was dropped and the city saved from a flood tearing

down through. The citizens then gave Mr. Francis a table service of solid silver.

Each state ought certainly to take measures to discover how high the water may possibly rise at all existing reservoirs, dams, etc., and to have careful estimates made of the damages involved. The channel problem is commonly more intricate, but not impossible of solution. I hope the hydrographers of the U. S. Geographical Survey are now busy up in central Vermont and western Massachusetts.

Providence, R. I., Nov. 14, 1927. JOHN R. FREEMAN.

Toe Erosion at Dams

Sir—In an article upon work done on the old wooden dam at Holyoke, Mass., in 1885, and "On Some Studies for a New Stone Dam for the Same Place," *Trans. Am. Soc. C. E.*, 1886, the subject of toe erosion and its prevention was briefly dealt with, as based on crude experiments made with 1:12 size models. Though crude, these experiments showed that toe erosion could at least be mitigated by prolonging the ogee, not horizontally, as states your editorial of Oct. 20, but gently rising downstream; and this form of apron was accordingly recommended.

Now let no one come back with a record of toe erosion at the Holyoke stone dam, built about 1900. The writer ceased to have charge at Holyoke in the fall of 1889, and, as sometimes happens in such cases, other views prevailed. The shape of ogee and apron built at Holyoke has not prevented toe erosion, and could have been foreseen as inferior in that respect to those derived from experiment.

New York City, Oct. 21, 1927. CLEMENS HERSCHEL.

Unstandardized Concrete Road Design

Sir—In reading the letter by Dean Rowe, which appeared in *Engineering News-Record*, Aug. 25, 1927, p. 318, one wonders why there should be complete standardization of concrete pavement design any more than we should have standardized wearing apparel regardless of climatic conditions. I think it is agreed that there could possibly be some reduction in the number of types, and some of the radical differences in type could be reconciled, such as thick edge versus thick center. But it must be remembered that most of these types have been in use at least five years, and with slight modifications have "worked" under the conditions prevailing in the locality of adoption—as for instance the unexplained success of Maryland's thick-center, thin-edge type. In the above I am speaking of pavement at least 6 in. thick. It also must not be forgotten that inertia has something to do with the case. Engineers are somewhat loath to abandon a design which has functioned fairly well in their locality, for something new which might not "work" under their conditions.

I also do not agree that the results of concrete walks have been universally good. These walks are subject to the same temperature curling, expansion, and contraction as are roads, but ordinarily they have no heavy concentrated wheel loads to break them down, or to wear the cracks that fork, as is the case with pavement. Furthermore, if the surface of the walk becomes uneven nothing is thought of it, but if a pavement becomes rough there would be much concern, for the public demands smooth riding highways. It must be further remembered that a 6-in. layer of cinders is laid under most foot walks, but owing to the rural nature of highway improvement such a cinder sub-base is not, in general, economically justified except under special conditions. It is no uncommon sight (in this section) to see concrete walk slabs permanently curled up so much at the four corners that the slab holds water.

I think it is well recognized by all thinking highway engineers that concrete pavement design should meet three main factors: traffic, soil, and climate. Various combinations of the above factors might produce a dozen "standard" designs which would "work" perfectly in the particular locality for which each type was designed. Considering all of these factors, I think anyone will concede it is not practicable to develop one or two standard designs to be used in all parts of the United States.

Concrete pavement should be as carefully designed to fit local conditions as is any other engineering structure. Thickness, weight of reinforcement, position of reinforcement, transverse joints, longitudinal joints, dowels, all of these are dependent on widely varying conditions and cannot be reduced to a simple formula covering all situations. In the last analysis, mature engineering judgment and experience in this specialty are necessary before a satisfactory design is evolved for given conditions. It must be admitted also that concrete slab design is still in the development stage and we have much to learn regarding it. Much valuable research work is being and has been done. I think Professor Terzaghi has shown many of us how little we know of soils; and that is only one phase of the matter. All of this indicates progress. I feel further that the maintenance man can help the research worker considerably. By that I mean from the chief maintenance engineer all the way down to the patrolman. The object is not complete standardization, as some would wish, but a knowledge of all the physical factors for which we must design, and a further reconciling of some of the radical differences of opinion prevailing at this time or of showing the physical reasons lying behind such differences of opinion. Then it will be possible to design pavement for any given set of conditions with full assurance of success.

New York, N. Y., Sept. 5, 1927. CHARLES M. NOBLE.

Sir—The same facts may produce a very different reaction in different individuals. The article on "The Trend of Highway Design," by A. G. Bruce and R. D. Brown in *Public Roads*, for March, 1927, bewildered Prof. Rowe by the lack of uniformity, whereas I was congratulating myself that it shows a surprising uniformity, considered as a mass of statistics. The variation is certainly not as great as that in many other types of construction. A study of design features of flat-slab warehouses or of concrete-topped woodpile dock walls, as actually built, for instance, would show much greater variation than do these federal-aid road projects. Furthermore, what variations exist in the tabular description of various types of roads given in the article may largely be explained as due to three causes: (1) logical and reasonable correlations which may be discovered from the data given; (2) causes taken into account by the designers but not indicated in this article; (3) failure of some localities to observe the most modern in practice—in other words, mistakes and non-conformities.

Taking up the data of the tabulation, it is at once evident that most of the heavier slabs are not reinforced, except at joints or edges. In every case except four, slabs with edges thinner than 9 in. are shown with considerable reinforcement. In general the thinner slabs are both reinforced more heavily and composed of a richer mix. The principal reason for this variation in exact amount of reinforcement is that none of these types has enough steel as yet—state organizations are very slow to incorporate in their estimates an added amount for a separate material recognized only as reinforcement, even though the latest experiments as well as experience with structural concrete show its advisability.

Anyone who has traveled along Iowa gumbo roads in wet weather can understand that possibly it is the poor subgrade naturally furnished in many sections of that state that leads to the adoption of a very heavy section, and a rich mix of concrete, particularly as it seems to be left unreinforced. Such states as New York, New Jersey and Connecticut, where traffic is extremely heavy, seem to be developing in the direction of both richer mixes and heavier reinforcement. Michigan is another state of poor natural roads and rather heavy traffic—result, a thick slab, with considerable reinforcement. Only two states show a 6-in. center slab, a nominal 1:2:4 mix, and no reinforcement. One state shows a 6½-in. slab, with 1:2:4 mix and no reinforcement, but in that state great care is taken with certain details that are rather neglected in some states—and at the same time, be-

cause many roads in that state are cracking up badly, there is some agitation for introducing more reinforcement. A correlation of the data of this table with subgrade conditions and condition of older slabs as to cracks and renewals is really needed to pass intelligent judgment about uniformity of design standards.

Data are given as to location of steel in 22 cases. Of these, 13 show that steel is used 2 in. from the top, one shows it 2½ in. from top, two show it top and bottom, one top or bottom, one in the middle, two near the bottom, and two near the bottom in the center but in the middle at the edges. Eliminating the one case where choice is allowed, 16 out of 21, or 76 per cent, require the top of the slab to be reinforced, as can be shown wise by a practical use of theory.

The tabular thicknesses fall into two distinct groups: eight Eastern states in one group, with an average uniform thickness of 7½ in., a rich average mix, and considerable reinforcement; thirty-six states in the other group, with average edge thickness of 8.8 in. and average center thickness of 6.3 in., and varying proportions of mix and reinforcement. Eighteen of these, just one-half, use 9-in. edge and 6-in. center. Evidently there are two distinct schools of thought as regards design of concrete roads.

Such details as roadway 15 ft. wide or great spacing of joints are clearly not in keeping with most modern practice and will probably disappear in the near future. Other details not in line with general practice evidently occur here and there through the data—some of them are certainly improvements, others are remainders from past practice. In considering variations in spacing transverse construction joints or any other detail, one should determine whether a majority of states are fairly uniform in practice, and then should try to discover whether the wide variations of a few individual states are due to new ideas, to eccentricity, or to exceptional conservatism.

With these considerations in mind certain tendencies stand out as evident. Where poor subgrade conditions generally exist, the tendency seems to be to thicken the slab, particularly the edge of the slab; whereas a high average altitude and good drainage conditions are reflected in thinner slabs. On the other hand, exceptionally heavy traffic correlates fairly well with richer mix of concrete and heavier reinforcement. There is no definite correlation between extremes of cold weather and use of top reinforcement, although theoretically this would be expected, but several states peculiarly liable to soft spots in road subgrade are using top reinforcement combined with thickened slab edges.

As to endurance of road slabs, it is a fact that some old slabs are still standing up well and others are not. I do not see how any one can expect concrete to resist temperature changes without considerable steel reinforcement. Lack of uniformity in subgrade or excessively heavy traffic may be taken care of by greater thickness, but not temperature changes and disintegrating effect of water, frost and ice. It seems very difficult to obtain the facts, but surely there is a correlation between service of existing slabs and the details of construction—including thickness of slab, mix and consistency of concrete, amount and location of reinforcement, and many other details which would affect strength and wearing qualities.

In summary, while my first impression of this article was very different from that of Prof. Rowe, my final conclusion is nearly the same—that whereas very definite tendencies of development are shown, still the resistance to soft spots in subgrade, to weathering, and to temperature changes should be considerably increased by use of more top steel and more uniform care to obtain first-class dense, resistant concrete.

MARSHALL G. FINDLAY,
Structural Designer.

Milwaukee, Wis.,
Oct. 1, 1927.

[The discussion of this subject appears to have extended as far as is necessary to make the contention clear. It is evident enough that there is diversity of practice in concrete road design and withal that a considerable degree of standardization exists. These are facts familiar generally to highway engineers and they are generally alert to their implications.—EDITOR.]

A Successful Direction Sign

Sir—In reference to the editorial and the comments of H. D. Ricker, of the General Electric Co., in *Engineering News-Record*, Sept. 1, p. 330 and Sept. 29, p. 523, it is noted that some five years ago a few combination "warning and direction" signs were tried out by the Delaware State Highway Department causing many favorable comments from road users.

The main state highway routes had been well marked with danger signs, set normal to the road center line and

COMBINED WARNING AND DIRECTION SIGN FOR HIGHWAY INTERSECTIONS

placed 300 ft. in advance, warning of road intersections. Direction boards, pointed on one end, were added at the top and bottom of these danger signs as indicated by the accompanying sketch; the top board always pointed to the right and the bottom board always to the left for uniformity.

While the shape and design of the danger signs warned drivers to get under stop control, the direction boards informed them of the towns to either side, and the placing of this information 300 ft. in advance of the road intersection gave them sufficient time not only to absorb it but also to prepare for the turn.

It is hardly necessary to point out that when direction signs are placed right at the road intersection, where so many are placed, a stranger seeking his way by the use of such signs, in order to read them, will stop on the intersection thus blocking and interfering with traffic and creating an accident hazard on both roads.

I. PAUL JONES,
Highway Engineer.

Dover, Del.,
Oct. 4, 1927.

Scioto River Suspension Bridge and Its Failure

Sir—The historical notes on bridges in the Ohio River territory given by D. B. Steinman in his article, "Ohio River Suspension Bridge at Portsmouth," in *Engineering News-Record* of Oct. 20, p. 620, recall the former suspension bridge at Portsmouth over the Scioto River about 300 ft above its junction with the Ohio. This bridge, built in 1850, failed in 1880 under the load of a block of stone weighing about five tons carried in a wagon drawn by three yoke of cattle. The failure of the bridge occurred when the load of stone was at about the midpoint of the 400-ft. span.

Floorbeams and floor of the bridge were of wood, trusses and handrail mostly of wood. The two upstream cables failed and the side sway then pulled the downstream cables loose from their supports on the piers. Examination showed the cables, though served with wire, to be a mass of rust. The cable wires in some sections were of normal size but at spots 2 ft. away from normal places would frequently be reduced to the thinness of a needle.

In building the bridge, the cables, about 4 in. in diameter were made on the ground, passed across the river, secured to the anchorages, and then hoisted to the tops of the piers. This fact is interesting now because the procedure on these cables in 1850 was very similar to that on the new Ohio River bridge at Portsmouth as described by Dr. Steinman.

SAMUEL P. BAIRD,
Consulting Engineer.

Columbus, Ohio.
Oct. 24, 1927.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Gasholder Explosion in Pittsburgh Wrecks Wide Area of City

Twenty-Six Persons Killed When 5,000,000-Cu.Ft. Holder Explodes—Cause Yet Undetermined

By Charles Stratton Davis
Consulting Engineer, Pittsburgh

At 8:43 o'clock on the morning of Nov. 14, there occurred one of the worst accidents ever experienced in Pittsburgh. A gas-holder 233 ft. in diameter and 208 ft. high, having a capacity of 5,000,000 cubic feet, located in the "Lower North Side," and owned by the Equitable Gas Co., exploded with terrible violence, killing 26 persons, injuring 465, of whom 95 are still in hospitals, and causing property damage extending over a wide area. There is a list of missing persons numbering about 50; from these and the hospital cases, the death list will likely be increased.

Damage to Buildings

The plant of the Pittsburgh Clay Pot Co., located on property adjoining the gas works, was badly wrecked, and a large portion of it collapsed, burying the workmen engaged therein. The loss of life here was large. From 100 to 150 employees, only about one-third have been accounted for.

Warehouses, manufacturing plants and residences within a range of two blocks were badly damaged. In some places, fronts were blown in, roofs lifted or collapsed, doors and windows destroyed, and plaster removed. A trip through the section of greatest damage shows a scene of desolation with few houses in fit condition for occupancy.

Across the Ohio River, on the "South Side," the damage was confined mainly to broken glass. In the "Golden Triangle," between the Allegheny and Monongahela Rivers, the damage was also mainly broken window glass. Plate glass windows were even broken throughout the business section of Pittsburgh. In Duquesne Way, which lies along the Allegheny River, the loss from this source was especially heavy.

The gas plant is located on the northerly shore of the Ohio River about four blocks below the junction of the Allegheny and Monongahela Rivers. It is equipped with three holders, one having a capacity of 6,000,000 cu.ft., one, a relief holder, with a capacity of about 600,000 cu.ft., and the

(*Continued on p.* 814)

Holland Tunnel Opened to Vehicular Traffic

At 12:01 Sunday morning, November 13, the Holland vehicle tunnel under the Hudson River between New York and Jersey City, was opened to traffic. Opening ceremonies were held on the previous afternoon, when gatherings at both the Jersey City and the New York plazas were addressed by Governors Alfred E. Smith and A. Harry Moore of New York and New Jersey, and by other political officials, tunnel commissioners and Ole Singstad, chief engineer of the tunnel. President Coolidge, by telegraph signal from Washington at 5 p.m., drew aside a pair of flags that closed off the New York entrance, and for two hours pedestrians were permitted to cross through both tubes of the twin tunnel.

Immediately at opening, just after midnight, capacity traffic passed through the tunnel. During the 24 hours of Sunday each of the new tubes carried something over 26,000 vehicles, which is approximately equal to the estimated maximum capacity. A large part of this first day's traffic was apparently sightseeing. Crowding of traffic at the approaches slowed up movement and made it at times impossible to maintain the intended spacing of 75 ft. between vehicles. While this gave an excessive ventilation load, the ventilation is reported to have been highly satisfactory, the carbon monoxide remaining below two parts per 10,000 at all times.

General Jadwin Speaks on Mississippi Plans and Public Works

Condemns Public Works in Interior Department—Hoover and Davis Emphasize Waterways

In an address before the Mississippi Valley Improvement Association at St. Louis, Nov. 15, Major General Edgar Jadwin, chief of engineers, U. S. Army, revealed some of the recommendations that will be made to Congress in connection with flood control on the Mississippi River. These recommendations will include the following:

(1) Strengthening the levees and probably raising them slightly.

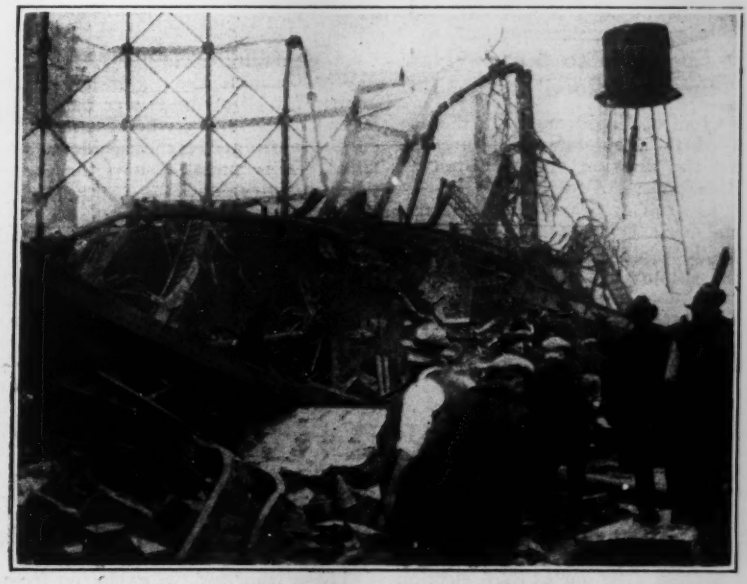
(2) More bank protection.

(3) Construction of spillways in the vicinity of New Orleans.

(4) Construction of floodways in the Tensas and Atchafalaya Basins.

These provisions, said General Jadwin, will restrict the flow in the main river in accordance with sound economics and the special conditions obtaining in each basin, but it may be found advisable to construct safety valve spillways to limit the damage incident to crevasses in case of a flood even larger than is being definitely provided for. General Jadwin also believes that it may be found neces-

(*Continued on p.* 816)



WRECKAGE OF 5,000,000 CU.FT. GAS HOLDER WHOSE EXPLOSION, NOV. 14, WAS DISASTROUS TO PITTSBURGH

New Railway Terminals at Boston and Cincinnati

Much discussed plans for two large railway terminals have taken more definite form during the past week. At Boston, Mass., the chairman of the Boston & Maine R.R. has announced plans for rebuilding North Station and at Cincinnati, Ohio, the city and railroad companies have come to an agreement concerning the construction of union passenger and freight terminals. Surveys are to be begun at once at Cincinnati in order that definite plans may be prepared.

At Boston the B. & M. Railroad will spend $1,100,000 on the preliminary stages of a plan which includes building a new and larger station on the site of the present North Station, a project which when completed will include a coliseum seating 18,500 people, a hotel, an office building, and a distributing terminal. Construction of the first units, the station proper and the coliseum, will be begun at once. Arrangements for leasing the coliseum have been made The total cost of the project is reported to be about $10,000,000.

Boulevard Bonds for $9,380,000 Approved in San Francisco

Eight boulevard projects calling for new or improved roadways, totaling 15.62 miles in length, were before the voters of San Francisco at the Nov. 8 election in the form of a bond issue for $9,380,000. The projects are part of the general scheme of development worked out by M. M. O'Shaughnessy, city engineer, in a period of years, and are all wide roadways. Only one of the eight will have a roadway as narrow as 100 ft. while one has a width of 240 ft. for a length of 2.1 miles. The bond issue was approved by a vote of 89,352 for, and 25,941 against the measure.

Army Engineers to Survey New England Flood Area

The Chief of Engineers, with the approval of the Secretary of War, has driected the division engineer, northeast division, at New York City, to submit as soon as practicable a report on the engineering features of the present flood in New England. The division engineer is also to take the necessary steps to insure collection of engineering data on this flood which will be of value in surveys and studies in connection with power development on navigable streams in the region.

New Jersey Votes Highway Bonds

Returns from the New Jersey state election held on Nov. 8, show a comfortable majority for the proposal to issue $30,000,000 highway bonds, according to the Newark *Evening News*. Reports from 2185 out of 2876 election districts in the state, give a total vote of 226,197 for, and 135,638 against.

Engineering Fifty Years Ago

From *Engineering News*, November 10, 1877

WORK on the Pittsburgh and Lake Erie R.R. is being pushed along rapidly. The grading from Youngstown to Beaver Falls will be finished within three months, and it is expected that trains will be running to and from these places by February. The line will be an unbroken route from Pittsburgh to Cleveland; the rails will be steel; the bridges and culverts, iron and stone; and the grade is being made with a view to putting down a double track.

Pittsburgh Gasholder Explosion

(*Continued from p.* 813)

one that exploded, which had a capacity of 5,000,000 cu.ft.

The holder that exploded had been empty for about three months during which time extensive repair work had been going on. It is reported that it was built in 1899. Corroded plates had been reinforced by electrically welded patches on the inside, and the repair work was nearing completion. The structural repairs were being made by the Riter-Conley Manufacturing Co., and at the same time, employees of the owners were engaged on other repairs. For about 10 days, and up until the morning of the accident, the Riter-Conley forces were idle. During this time the holder tank was being filled with water preparatory to putting the holder into operation. The holder has five lifts, and at the time it exploded, one of these lifts was about half way up, and was supposed to contain air. The largest tank was partly filled with gas, but to what extent is not known at this time.

Explosion Cause Unknown

What caused the explosion is not known, for all of the twelve men of the Riter-Conley forces, who resumed work on the morning of the accident, were killed. This matter is now the subject of an inquiry, and the cause may be determined.

While the cause of the explosion is unknown, it appears beyond question that the explosion occurred in the 5,000,000 cu.ft. holder. When this holder exploded, its water tank completely collapsed, and released all the water it contained. Parts of this holder were shot against the largest of the three, and broke open each of the lifts, besides piercing the shell of the water tank and releasing much of the water. The result was to flood the immediate vicinity to an extent that made rescue work difficult. The smallest of the tanks was damaged, but the extent of the damage was confined mainly to its roof.

Those who saw the explosion from a distance described what they saw as a revolving ball of fire, ascending skyward, with its outer surface carrying some smoke, which increased as it rose, until the fire was completely hidden by the smoke.

The heat from the explosion was intense, as it was reported to have been felt through windows across the Ohio River. How some of the survivors lived in the immediate vicinity of the tanks is difficult to understand unless it was because they were submerged in water and thus escaped the heat.

Newspaper reports quote Government Weather Forecaster W. F. Brotzman, who was seated on the top (26th) floor of the Oliver Building, as saying: "As if given a mighty push, the Oliver Building swayed something like that caused by an earthquake. The air was so compressed by the violent concussion that its pressure, as shown on the barometer, became greater by five-hundredths of an inch."

Voters of New York State Pass Important Amendments

Chief among the constitutional amendments which was passed by the voters of New York State at the election Nov. 8 was that giving the city of New York permission to increase its debt limit by $300,000,000 for the construction and equipment of new rapid-transit railroads. The amendment also carried a provision to exclude this sum in the calculation of the city's borrowing power and another provision excluding all water debts from computation of the debt limit of cities generally throughout the state. This latter provision allows cities, when ascertaining their power to become indebted, to exclude debts, heretofore or hereafter incurred, up to the amount of $10,000,000 in the case of cities with a population of from 250,000 to 1,000,000 and up to the amount of $5,000,000 in case of cities with a population of from 175,000 to 250,000, for so much of the cost and expense of any public improvement which by local ordinance or legislation is to be raised by investment upon local property or territory.

Another important legislative amendment which was passed authorized the creation of a debt of the state not to exceed in the aggregate $300,000,000 to provide money for the elimination of railroad grade crossings under state supervision. Moneys thus provided are to be used for grade-crossing elimination generally on the following basis—50 per cent to be borne by the state and the county in which the crossing is located or by the state and city in which it is located if the city contains two or more counties, and the other 50 per cent by the railroad company.

Other amendments passed provided: for construction of a road through the state forest preserve up Whiteface Mountain in the Adirondacks; for further privileges to counties in condemning land for public improvements; and for providing for the extension of home-rule rights by referendum to the people of the territories which cities attempt to annex.

San Francisco Vote on Bay Bridge Question

Preference for public ownership of the proposed bridge across the Bay from San Francisco to Oakland, Calif., was expressed by San Francisco voters at the Nov. 8 election. Two measures were on the ballot to get an expression of policy for the guidance of the board of supervisors, as noted in *Engineering News-Record*, Oct. 20, 1927, p. 649.

There were 46,149 votes for the proposition providing for the financing, construction and operation of the bridge under public ownership, and 43,682 votes against it. The second proposal, i.e., that the bridge should be erected by private capital and ultimately revert to the city received 40,830 "yes" votes; and 49,005 "no" votes.

Trouble at Indianapolis

Political fights at Indianapolis, Ind., are affecting the city's technical organization. Political interests acquired control of the Board of Sanitary Commissioners, which had previously been involved in political mix-ups (see *Engineering News-Record*, Aug. 26, 1926, p. 356) and removed the heads of three divisions of its work by abolishing their positions. The men thus removed include: C. K. Calvert, engineer in charge of operation of the new sewage-works, who has been connected with the disposal project since 1921; M. W. Tatlock, his principal assistant; Floyd Baber, for seven years superintendent of the garbage reduction plant; and Truly Nolen, for seven years in charge of the garbage collection system. The Indianapolis *Star*, commenting upon "spoilsmen" control, says: "The scientific branch of the [sewage] plant apparently will be expected to function without technical supervision." The *News* also throws light on the situation by remarking of Mr. Calvert: "Nobody knows anything of his politics. He was hired for his ability as a chemist and not for his capacity as a ward worker."

Paving Contracts For Arthur Kill Bridges Approved

N. J. Governor Declines to Reverse N. Y. Port Authority Action—Cost Comparisons Made

VETO of the contracts for paving the Arthur Kill bridges described in *Engineering News-Record*, Nov. 10, 1927, p. 744, has been refused by Governor Moore of New Jersey as being unwarranted by the evidence presented. The request for veto action came from state senator E. L. Richards of Atlantic City who urged as reasons that the specifications were vague, and that a patented pavement was favored. These charges were denied by the Port of New York Authority under whose administration the bridges are being built. To meet the charges the Port Authority called a hearing, on Nov. 10, at which evidence was given by contractors and engineers. At this hearing Governor Moore was represented by C. F. Bedwell, engineer of construction, New Jersey State Highway Commission, assistant attorney general Bacon and Hugh Kelley, personal aide of the governor. No representation was made by Senator Richards or by others who supported his charges. The Port Authority called a number of witnesses.

As noted in *Engineering News-Record*, Nov. 3, 1927, p. 725, the contract for the Outerbridge Crossing between Tottenville, S. I. and Perth Amboy, N. J. was awarded to the Cornell Contracting Co., New York, for $626,730. There were six bids on this work, ranging from that of the Cornell company to a high figure of $1,065,060. The like contract for the bridge between Elizabeth, N. J. and Howland Hook, S. I., went to Albert A. Volk, Inc., New York, for $478,650. There were seven bids for this contract ranging from $478,650 to $887,950. The Outerbridge Crossing has a paved length of 8,700 ft., and the Howland Hook Crossing a corresponding length of 7,100 ft.

The contracts called for either of two kinds of concrete pavement construction specified as follows: "The engineer will direct whether the concrete slab shall be constructed with trap rock coarse aggregate throughout, or ordinary aggregate with an excess of trap rock worked into the upper surface." Except for the difference in aggregate the pavement structures were identical. In respect to the construction of the trap rock wearing surface the specifications were:

> The surfacing stone shall be cast upon the pavement by a method which will equally distribute a single course of stone of the size specified over the surface area of the concrete slab.
>
> A cubic yard of surface stone shall cover not more than 50 sq.yd.
>
> Additional surfacing stone shall be used wherever the grading and size of base ma-

(Continued on p. 816)

Building Trades Department of A. F. of L. Criticized

At the recent meeting of the administrative board of the American Engineering Council, the following resolution was passed:

Resolved: That American Engineering Council strongly deprecates the withdrawal of the Building Trades Department of the American Federation of Labor from participation in the operation of the National Board for Jurisdictional Awards, and suggests to the other organizations party to the agreement, viz., the American Institute of Architects, the Building Trades Department, the Associated General Contractors of America and the National Association of Building Trades Employers, that, if after reasonable time the Building Trades Department does not see fit to modify its position, such associations give their consent to the dissolution of the agreement and an abandonment of the plan of the Jurisdictional Board.

HOLLAND TUNNEL USED BY 52,000 VEHICLES DURING THE FIRST 24 HOURS

Wide World Photos

THE TOLL booths at the New York entrance, and the vehicles emerging from the New York exit are shown in the illustrations. A spacing of 75 ft. is required between cars in the tunnels, as may be seen in the exit photo. On Nov. 13, the first day of operation, 52,285 vehicles, mostly sightseeing automobiles, used the tunnels while, during 24 hr. Nov. 14, 17,726 vehicles, of which 30 per cent were trucks, were accommodated. East and west bound traffic is about equally divided.

Longview Bridge Project Approved

Rehearing on the clearance plans for a bridge over the Columbia River between Longview, Wash., and Rainier, Ore., before the Secretaries of War, Agriculture and Commerce has resulted in approval of the plans. After the first hearing, last spring, the board of secretaries on June 15 declared itself willing to approve the application if larger clearances were provided horizontally and vertically (*Engineering News-Record*, June 23, p. 1037). Revised plans were then submitted providing the clearances asked for (1,120 ft. instead of 1,000 ft. clearance width of central span; 185 ft. mid-span clearance height, 175 ft. height at the piers), as well as reducing the roadway width from 37 ft. to 27 ft. Later a further increase in clearance height was made (to 195 ft. and 185 ft.), at the request of the board of secretaries. In this latter form the plans have now been approved as to clearances.

The board's findings, under date of Nov. 5, state that public convenience will be served by the proposed bridge; that the location is feasible and the bridge will not obstruct navigation or injure Columbia River commerce; and that the clearances provided will adequately protect the interests of all the commerce on the Columbia.

This action was taken after hearing the protests of representatives of Portland, which city has steadily opposed the Longview project.

Arthur Kill Bridge Paving

(*Continued from p.* 815)

terial will permit, without increasing the total volume of the slab or burying the surface stone more than ½ in. beneath the surface.

The surfacing stone shall be forced into the surface of the concrete and made a part thereof, and the whole mass shall be solidified in such a manner as to produce a pavement of maximum density, uniform in character throughout, free from voids and depressions and true to cross section.

In the hearing, categorical denial was made by the engineer of the Port Authority that any patented process was required by these specifications. Instead they asserted that various common ways of doing the work were available. The law of New Jersey does not prohibit the use of patented pavement, but does provide that no royalties shall be included in state work, and also that the specifications shall admit of open competition with non-patented materials or processes.

Cost Comparisons

Bearing on the cost of the paving as bid it was shown that the finished concrete slab on the Elizabeth-Howland Hook Bridge would cost $9.64 per sq.yd. and on the Outerbridge Crossing $10.77 per sq.yd. The per-sq.yd. cost for paving the main span of the Philadelphia-Camden Bridge was $14.50 and for the approaches of that bridge, $15.63. For the Victory Bridge over the Raritan River, the per-sq.yd. cost to the New Jersey State Highway Commission was $11.26. The North End Bridge at Springfield, Mass., it was stated, averaged $12.40 per square yard, and the new Poughkeepsie Bridge, $9.11. The Poughkeepsie Bridge, and most of the other bridges used in the comparison, has an 8-in. concrete slab. while the concrete slabs on the Arthur Kill Bridge will be 9½-in. thick. The Arthur Kill bridges also are designed for 25-ton trucks, and the other bridges are designed for 20-ton trucks.

Compared with viaducts that the New Jersey State Highway Commission is now building in Hudson and Essex counties, the bridge paving costs are less for the Arthur Kill bridges.

Jadwin Floods and Public Work

(*Continued from p.* 813)

sary for the federal government to bear an increased proportion of the cost of flood control work.

Opposes Public Works Bureau

At another point in his address, General Jadwin attacked the effort to centralize the public works functions in the Interior Department. A consolidation of this sort, he declared, will "result in more red tape, greater cost, more complications and less satisfaction."

"The Government's engineering services," continued General Jadwin, "do not overlap or duplicate. Information is freely exchanged. The idea that there is confusion, overlapping and duplication of the engineering work performed by the government is not founded on facts, as any one who is interested can ascertain freely.

"Any organization in which a technical profession is taken out of its position of technical assistant, and made an independent organization, is faulty in basic principles. It would be unreasonable to set up a separate medical department for the government by transferring thereto all physicians and surgeons from the existing services.

"A centralized technical unit made coordinate with operating and producing units, which it is supposed to serve, would involve delays, disagreements, and unnecessary expense, which big business organizations do not tolerate. The setting up of a public works bureau in the Interior Department would have the same result in government affairs. There would be constant disagreements between that department and those using the facilities which it creates. Differences could only be settled by the two cabinet members concerned, or by the President. A department controlling all public works would affect every congressional district in the United States. Its secretary would control the disposition of immense natural resources. He could be the most influential and politically powerful member of the cabinet."

Speaking before the same association, Secretary Hoover and Secretary Davis both emphasized the need for improved navigation facilities in the Mississippi Valley in order to remedy the disparity which now exists in transportation costs between the middle west and the seaboard states. Secretary Hoover believes that the needs of navigation should not be lost sight of in flood relief work on the Mississippi. On this point he said "in our necessity to remake and energetically construct such flood control works as will guarantee protection against these calamities, we must not be diverted from our march toward the improvement of our inland waterways." Nor does he believe that railways will suffer through the extension of inland waterways and the opening of the St. Lawrence route. He anticipates an even greater increase in population in the next 25 years than occurred in the past 25 years, an increase which will make it necessary for the railroad to be supplemented by a fully developed system of waterways.

Resolutions Adopted

The resolutions adopted by the association at the end of its two-day session, asked (1) that Congress consider the chief of engineers' plans as the proper solution (2) that the entire expense be borne by Federal Government (3) that the funds be made promptly available, and (4) that navigation be considered along with flood control. The program already adopted for navigation on Mississippi Valley streams should not be curtailed.

Cincinnati Extends Its Railroad Lease for 99 Years

At the election November 8, the voters of Cincinnati, by a vote of 7 to 1, extended the lease of the Cincinnati Southern R.R. for 99 years. The Cincinnati, New Orleans & Texas Pacific Railway Co., a division of the Southern System, is the lessee. The railroad which connects Cincinnati with Chattanooga, Tenn., was started by the citizens of Cincinnati shortly after the Civil War in order to hold the city's prestige as a gateway to the south; it was completed in 1889, and is 346 miles long. It is stated, that under the modified and extended lease, the city will have a surplus income above the interest charges of almost three-quarters of a million dollars a year. This money goes into the city's general interest fund to pay interest on other bonds.

The scale of rentals for the extended lease is as follows:

1926-1946—$1,250,000 a year, plus 3 per cent of the net profits.

1947-1986—$1,450,000 a year plus 4 per cent of the net profits.

1987-2006—$1,600,000 a year plus 5 per cent of the net profits.

2006-2026—$1,700,000 a year plus 6 per cent of the net profits.

From this rental the city must pay interest and sinking fund charges on $14,900,000 of the original construction bonds, which amounts to about $600,000 a year.

Washington Notes

A FAVORABLE report has been made by the Chief of Engineers in connection with the proposed development on the North River in Washington. The Twin Harbor Land Co. is seeking a preliminary permit for a project on which 40,000 hp. can be developed.

The Chief of Engineers also has issued a favorable report in connection with a project of the North Connecticut Power Co. on the Connecticut River below Springfield, Mass. The company is seeking a license covering the project which is expected to develop 65,000 hp. A condition of the license will be the construction of a lock which will permit the navigation of the river above the dam.

Another favorable report was submitted to the commission in connection with the application of the Alabama Power Co. for a license covering a 20,000 hp. project on the Warrior River at Dam No. 17.

THE City of Sacramento has filed with the Federal Power Commission an application for a license for its Silver Creek project on the South Fork of American River in Eldorado County, California. The applicant states that the requirements of the preliminary permit have been discharged. It is planned to develop 160,000 hp. Power is to be developed as an incident to a supply of water for municipal purposes. There will be two main storage reservoirs. The Union Valley reservoir is to have a capacity of 165,000 acre-ft. It will be located on the main fork of Silver Creek where a dam 325 ft. high and 1,625 ft. long will be constructed. The Ice House reservoir will contain 45,000 acre-ft. and will be located on the South Fork of Silver Creek. The dam there will be 150 ft. high and 1,510 ft. long. An auxiliary dam will be 46 ft. high and 700 ft. long. In addition, a reservoir with 2,950 acre-ft. capacity will be constructed solely for water supply.

The commission is not expected to act on the application in advance of the approval of the project by the voters in the municipal water supply district. At the last election the bond issue did not command the necessary two-thirds vote.

Personal Notes

W. B. MONTGOMERY, for the past fourteen years county engineer for Hinds County, Mississippi, has resigned and will devote his time to general engineering practice in Mississippi and adjoining territory.

WILLIAM D. SMITH, for three years structural engineer designing timber, steel and concrete structures in the Pacific Northwest, has joined the staff of the Portland district office of the National Lumber Manufacturers' Association as field engineer for the Trade Extension campaign. Mr. Smith was assistant engineer of the port of Seattle for two years, designing docks and warehouses, and for four years was in Tacoma as chief draftsman for the port designing lumber docks and lumber equipment, and was chairman of the committee that wrote the present Tacoma building code.

LIEUT. COL. G. R. LUKESH, formerly engineer, Ninth Corps Area, San Francisco, Calif., has been appointed division engineer, Northern Pacific Division, vice Col. Wm. J. Barden, recently appointed division engineer, Northeast Division at New York. The headquarters of the Northwest Division has been moved back to Portland, Ore., from Seattle from which it was transferred about six years ago due to the large amount of work going on there at that time.

PAUL R. BROWN, city engineer of Indianapolis, Ind., has resigned.

MILO S. KETCHUM, dean of the school of engineering of the University of Illinois, received on Nov. 3 the degree of doctor of science from the University of Colorado, where he was for fifteen years dean of the College of Engineering and professor of civil engineering.

ROBERT H. ERLEY, village engineer of Dearborn, Mich., for three years and village engineer at Grosse Pointe, Mich., for the preceding five years, was recently appointed city manager of Dearborn.

J. E. KIRKHAM, Pierre, S. D., bridge engineer of the South Dakota State Highway Commission, has resigned and will engage in private consulting engineering practice especially in bridge designing. Mr. Kirkham has had charge of bridge construction in South Dakota during the construction of five major highway bridges. Formerly he was consulting engineer for the Iowa State Highway Commission.

EVERITT W. WILSON has been elected a vice-president of R. W. Hebard & Co., Inc., New York City, and is in charge of the Colombian business of the company with headquarters in Medellin, Colombia, where the company has extensive road work under construction. Mr. Wilson formerly spent several years with J. G. White & Co. on work in the Philippines, Uruguay and the Argentine.

COVINGTON K. ALLEN, who has been connected with the sewerage and water departments and the Public Improvement Commission, of Baltimore, Md., has been appointed an engineer of highways in the Bureau of Highways.

STANLEY BROWN has recently joined Stone & Webster, Inc., Boston, Mass., as an engineer in the electrical division. Mr. Brown was formerly with McClellan and Junkersfeld, Inc., and Dwight P. Robinson & Co., Inc.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Dallas, Texas, Nov. 14-18, 1927.

ASPHALT PAVING CONFERENCE: Under the auspices of the Asphalt Association and Association of Asphalt Paving Technologists; annual conference Atlanta, Ga., Nov. 28-Dec. 2, 1927.

HIGHWAY RESEARCH BOARD, NATIONAL RESEARCH COUNCIL, Washington, D. C.; Annual meeting, Washington, D. C., Dec. 1 and 2, 1927.

INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS, Chicago, Ill.; Annual Conference, Detroit, Mich., Jan. 9-10, 1928.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 18-20, 1928.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 23-27, 1928.

THE NEW ENGLAND WATER WORKS ASSOCIATION, assembled in Boston on Nov. 9 for a superintendents' day meeting, sent a telegram to the governors of the New England states offering the services of an emergency committee for assisting in the rehabilitation of water systems, damaged by the recent floods, by furnishing engineering advice and the procurement of supplies and of skilled labor.

Obituary

W. H. HOYT, Duluth, Minn., chief engineer of the Duluth, Missabe & Northern Railway Co., died Nov. 10 at Rochester, Minn., aged 60 years. Mr. Hoyt was born at Owatonna, Minn., and was a graduate of the University of Minnesota. For some years he was assistant engineer of the Duluth & Iron Range Ry., then assistant U. S. engineer, Lake Superior District, then assistant city engineer of Duluth. From 1903 he had been with the Duluth, Missabe & Northern Railway Co., beginning as assistant engineer and becoming chief engineer in 1918.

REUBEN B. SLEIGHT, assistant to Secretary Herbert Hoover, U. S. Department of Commerce, detailed to work out engineering problems, was fatally injured Nov. 14 at Montpelier, Vt., when the airplane in which he had made the flight from Mitchell Field, New York, overturned in the attempt at landing. Mr. Sleight was born at Laingsburg, Mich., and was educated at the University of Michigan. He spent some years in hydraulic engineering in Colorado, Arizona and New Mexico.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Concrete Road Yardage

For October the square yardage included in concrete pavement contract awards according to the Portland Cement Association was 5,527,085 for roads; 3,686,570 for streets, and 586,575 for alleys; or a total for the month of 9,800,230 sq.yd.

The accompanying table summarizes the statistics for the current year:

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1927

Month	Roads	Streets	Alleys	Total All Classes
Jan....	2,656,118	1,504,059	75,352	4,235,529
Feb....	2,336,031	1,935,262	119,382	4,390,675
March	5,134,974	3,866,102	298,667	9,299,743
April...	10,264,336	4,931,954	285,924	15,482,214
May ...	8,234,755	5,601,627	397,220	14,233,602
June...	8,424,051	6,977,602	673,350	16,075,003
July...	7,298,618	4,903,789	412,721	12,615,128
Aug....	10,725,030	5,820,033	479,369	18,024,432
Sept....	6,872,398	4,365,135	343,270	11,580,803
Oct....	5,527,085	3,686,570	586,575	9,800,230
Totals	67,473,396	43,592,133	4,671,830	115,737,359

Business Notes

CANADA CEMENT CO., LTD., has recently been purchased by Wood, Gundy & Co., Ltd., bond dealers of Toronto, Ontario, in one of the largest industrial transactions ever made in Canada, involving a sum of $46,875,000. The new owners are reorganizing the financial structure of the organization. Frank T. Jones has resigned as president and general manager, but will retain his position on the board of directors. He is succeeded as president by A. C. Tagge, who has been with the company since its inception 18 years ago, and for some years has been vice-president. J. D. Johnson, who has been general sales manager of the company, becomes vice-president and general manager. H. L. Doble, formerly comptroller and secretary, now becomes vice-president and comptroller.

YEOMANS BROTHERS CO., Chicago, manufacturer of sewage ejectors and pumping machinery, announces the appointment of Dempster Mill Mfg. Co. at Amarillo as representative in northwestern Texas. It will handle the complete Yeomans line, which is composed of sewage ejectors, bilge pumps, water supply, circulating and other centrifugal pumps and condensation return pumps.

HENDRICK MANUFACTURING CO., Carbondale, Pa., manufacturer of Mitco steel floor grating, treads, etc., announces the appointment of the following representatives: J. E. Beattie, Greenville, S. C.; Boiler Equipment Service Co., Atlanta, Ga.; Latex Steel & Machinery Co., Beaumont, Texas; W. A. Sedwick Co., Dallas, Texas.

STAR DRILLING MACHINE CO., Akron, Ohio, announces that it has just appointed the Machinery Supply & Manufacturing Co., Fort Wayne, as its distributors in northeast Indiana and four adjoining counties in Ohio.

LINCOLN ELECTRIC CO., Cleveland, Ohio, announces the appointment of E. A. Thornwell, Atlanta, Ga., as its representative for Georgia and eastern Tennessee. John Van Horn, factory engineer, has been attached to the Atlanta office to assist Mr. Thornwell.

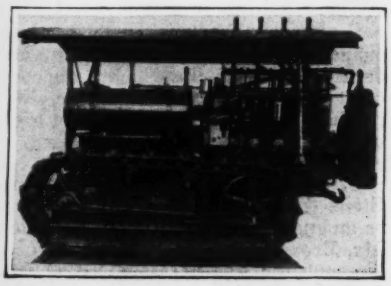
T. L. SMITH CO., Milwaukee, Wis., has appointed Stuart S. Smith Co., San Francisco, Calif., as its distributor in northern California and western Nevada.

R. D. FARIS has been appointed Cleveland district representative for the Rollway Bearing Co., Inc., of Syracuse, N. Y., and will make his headquarters in the Leader Bldg. in that city.

New Developments

Diesel Engine Installed on Crawler Tractor

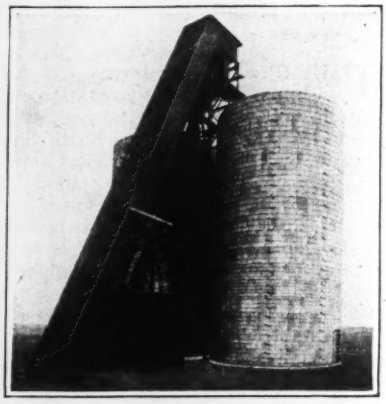
In extending the applications of its small Diesel engines, already used on several well-known makes of power shovels, the Atlas-Imperial Engine Co., Oakland, Calif., has perfected an installation on the "Caterpillar" crawler tractor. The mounting of the engine in the tractor has involved no mechanical changes other than the furnishing of engine supports and an extension on the frame permitting movement of the radiator forward about 10 in. The tractor clutch transmission is used without any modification, and the positions of other component parts of the machine are not materially changed.



Special attention has been paid to the protection of the engine from the abrasive dust normally encountered in road service. The rocker arms, valve tappets, and spray valves have been entirely inclosed, and oil filters have been adapted to protect the oil supply. Air filters are also used to prevent entrance of dust with the intake air. The engine shown in the illustration is a 60-hp. 6½-in. bore by 8½-in. stroke machine. The company states that while the first cost is somewhat more than for a gas engine, the fuel savings more than make up this difference.

Concrete Storage Bins

Cylindrical concrete storage bins, which are sold completely erected on the job with a guarantee of five years, have recently been developed by the Besser Sales Co., Chicago, in diameters of 10, 12, 14, 16, 18, 20, 22 and 24 ft. and in any height up to 60 ft. The

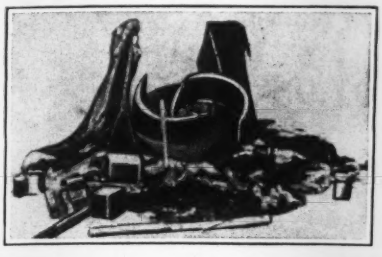


bins are rigidly built with a factor of safety of 6, which permits erection of pent houses and crushers and screens, if necessary, on top of the bins, eliminating the necessity of frames to carry the conveying machinery. Any desired slope to the bottom of the bin can be furnished. The illustration shows two 20-ft. diameter by 40-ft. high bins being fed by a Besser heavy type bucket elevator.

New Pump Designed to Handle Sewage Without Clogging

A new pump designed to handle, without clogging at the impeller, raw sewage, pulp, trash and other liquids containing solid or semi-solid particles has recently been installed in several locations by the Morris Machine Works, Baldwinsville, N. Y. Two of these pumps, one with a 12-in. and the other with a 10-in. suction and discharge, are being utilized by the Brooklyn Bureau of Sewers at Coney Island, N. Y. Both are of vertical design with overhead electric-motor drive, and are set in pits. Horizontal units are also built with the same pumping characteristics.

The outstanding features of the pumps are the volute casing, with special provision for smooth flow, and the impeller. The latter is made of bronze or cast iron as conditions may demand. The impeller uses two heavy curved vanes to form extra large water passages. For some of the pump sizes, the

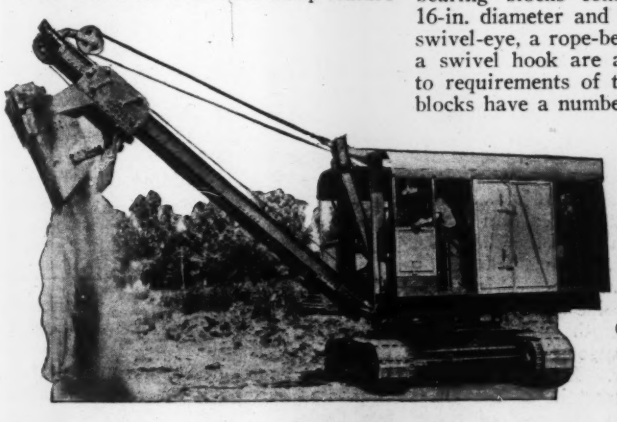


impeller is designed to pass solids of 1-in. smaller dimension than the pump suction and discharge diameter. In the illustration is shown the impeller of a 10-in. pump and some of the material passed without clogging in its shop test. The longest stick that went through without breaking was 12 in., larger ones being chopped up by the impeller.

The pumps are built in sizes having suction and discharge openings ranging from 3 in. to 20 in., with impellers from 8 in. to 40 in., to pass solids of maximum dimension ranging from 2 in. to 12 in. and for maximum capacities of from 450 to 16,000 g.p.m.

New Skimmer Scoop Is Attached to Shovel

A new skimmer scoop has been adapted to the power shovel manufactured by the Speeder Machinery Corp., Cedar Rapids, Iowa, for which, among others, three special features are pointed out: (1) Both a high and low speed are used on the drums as well as on the traction. (2) A patented bucket trip is used on the new skimmer, the bucket dumping from the back instead of from the bottom. (3) And a traction lock is used which prevents bucket travel away from the work, and yet allows movement toward it. For example, during the tests the machine was pushed back several inches, because of the operation of this lock, when the operator struck a hidden manhole. The back-dump feature is claimed to give a dumping clearance greater than could be obtained with a bottom dump, and also to add to the life of the bucket by eliminating the hinge on the bottom where the maximum load was carried.



Electric Operated Car Puller Uses 5, 7½ and 10-Hp. Motors

For moving and spotting railroad cars in factory or construction plant yards, the Galion Iron Works Mfg. Co., Galion, Ohio, has developed a new car puller which can be supplied with a 5, 7½ and 10-hp. electric motor as desired. Gear reduction is by means of cut steel gears running in a bath of oil in a dust-proof, cast-iron housing of heavy ribbed construction. The capstan is vertical, permitting pulling from any direction. In the illustration, a house has been

built beside the capstan to protect the rope. Such a plan is very convenient. No protection is needed for the capstan or motor.

Improved Type Single-Sheave Block for Cableways

A new type of single-sheave block, which is claimed to possess the requisite strength for drag scraper and slackline cableway plant, and yet is lighter in weight than any block previously designed for this work, has recently been developed by Sauerman Bros., Inc., Chicago, Ill. There are two models of the new block—with bronze bushed bearings and with roller bearings. Bronze bushed blocks are manufactured with sheaves of 12-in. diameter and up while the roller-bearing blocks come with sheaves of 16-in. diameter and up. A pin-bearing swivel-eye, a rope-bearing swivel-eye or a swivel hook are available, according to requirements of the user. The new blocks have a number of important features. By lifting one pin from the yoke, the side of the housing can be opened up for the removal of the rope, eliminating the threading of cables through the blocks. Cast steel frames of open construction are used. The flanges of the sheaves are protected by a heavy bead on the housing to eliminate any possibility of the rope fouling the sheave. Bearings are designed to take end thrust as well as radial pressure. Lubrication is provided through the sheave and not through a center bored axle. A grease reservoir is provided around the bearing in both the bronzed bush and the roller bearing type. Solid phosphor bronze bushings with two grease ports are used on one side while Timken tapered roller bearings are used on the other. Provision is made on the blocks for supporting or counterbalancing them when operated in positions which require it.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. Sixth Annual Show. New York City, Dec. 5-10.

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington, D. C.; Annual Convention, Detroit, Jan. 4-6, 1928.

ASSOCIATED EQUIPMENT DISTRIBUTORS, Milwaukee; Annual meeting, Cleveland, Jan. 6-7, 1928.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 16-19, 1928.

New Publications

Winter Concreting—ATLAS LUMNITE CEMENT CO., New York City, has made available a folder describing winter use of its cement. Illustrations of winter construction, 2 charts showing compression tests and temperature records, and a page of suggestions for using Lumnite make up the folder.

Technical Paints—CHEESMAN-ELLIOT COMPANY, INC., 639 Kent Ave., Brooklyn, N. Y., has published a 40-p. booklet describing its various types of paint for such uses as engine enamel, bridge paints, floor enamel, paints for tanks, gas holders, etc. The catalog is thumb indexed for easy reference and is illustrated with photographs of structures upon which the company's technical paints have been used.

Motor Trucks — WICHITA MOTORS CO., Wichita Falls, Texas, has published four new booklets, each giving complete specifications on one of its motor truck models. In addition, the various important parts of each truck are illustrated and described. These models include a 1½-ton, 2-ton, 3-ton, and a 3-ton oil field special.

Business Side of Construction

Facts and Events that Affect Cost and Volume

This Week's Contracts—With Comparisons

Minimum costs observed are: $15,000 for water-works and excavation, drainage, irrigation, levee, river and harbor projects; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, institutional, religious and other buildings.

Week ended	Public Work	Private Work	Total U. S.
November 17, 1927.	$20,239,000	$28,514,000	$48,753,000
November 10, 1927.	11,531,000	71,368,000	82,899,000
November 18, 1926.	19,264,000	36,814,000	56,078,000
Jan. 1 to date			
1927	1,135,215,000	1,691,492,000	2,826,707,000
1926	981,481,000	1,612,362,000	2,593,843,000

E.N.-R. Index Numbers

On November 1, 1927

COST	VOLUME
201.98	269
Last Year 210.80	Last Year 244

The Index Numbers are published in detail and with charts in the first issue of each month. The Cost Index is given in full from 1903 through 1926, with a thorough explanation of its method of computation, and a graphic comparison with many other index numbers, in the 48-page pamphlet entitled Engineering News-Record Construction Costs.

Weekly Construction Market

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, per 100 lb....	$3.34	$3.75	$4.00	$3.10	$3.35	$3.87½	$3.00	$3.00	$4.00
Structural rivets, per 100 lb....	5.00	4.00	4.75	3.60	3.85	4.64	5.50	5.25	5.50
Reinforcing bars, per 100 lb.....	3.24	2.99	2.75	2.50	2.87½	3.77½	2.95	3.00	3.7
Steel pipe, black, 2½ to 6 in.....	48%	40%	54%	51%	48%	41%	42@53.8%	48%	.....
Cast-iron pipe, 6 in. and over.	40.60	34.50	52.00	36.20	40.50	52.00	39.00	53.00	41.00
Concreting Material									
Cement, without bags, per bbl. .	2.35†	2.45	2.05	2.05	2.22	2.85	2.51	2.65	1.41
Gravel, ¾ in., per cu.yd.....	1.75	2.20*	2.38	2.00	1.25*	1.90	1.80	1.25	1.90*
Sand, per cu.yd.	1.00	1.75	2.00	2.00	1.25†	1.00	1.40	1.25	1.35*
Crushed stone, ¾ in., per cu.yd...	1.85	2.50*	2.83	2.00	1.25*	2.50	1.70	2.50	2.00*†
Miscellaneous									
Fir, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.	.....	.....	.....	39.50(S4S)	36.75 @38.75	34.25	27.00	24.00	+55.00†
Pine, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.....	60@61†	34.00	56.00†	.....	.....	.....	.....	.....	.....
Lime, finishing, hydrated, ton...	19.45	21.50	19.00	20.00†	25.50	24.00	27.50	24.00	21.00
Lime, common, lump, per bbl ..	2.35@2.50‡	1.25	1.82	1.50†	1.70	2.70‡	1.70	2.80‡	10.00*
Common brick, per M	16.00@18.00†	11.50	13.60	12.00†	13.75†	8@12	14.00	14.00	20.25
Hollow building tile, per block..	Not used	.068†	.103	.....	.072	.085	..	.10	.10
Hollow partition tile, per block	.0966	.068†	.103	.076†	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl., per gal.	+.79½	.83½	.85	+.83	+.86½	.88	.84	.98	.93
Common Labor									
Common labor, union, per hour.	.90⅝	.30	.....	.90	.....	.....	.50@.60	.70	.....
Common labor, non-union, hour.	.....	.25	.30@.50	.82½	.45@.60	.31½@.50	....	.62½	.30@.35

*Ton. †Delivered to job. ‡280-lb. net. +Advance. —Decline.

Explanation of Prices

Structural Shapes: Beams, 3 to 15-in.; channels, 3 to 15-in.; angles 3 to 6-in., ¼-in. thick; tees, 3-in. and larger. Prices are per 100-lb., at warehouse, in less-than-carload lots.

Structural Rivets: Round and cone head, per 100-lb., in full keg lots, at warehouse.

Reinforcing Bars: Rolled from billets, ¾-in. and larger, per 100-lb., out of stock at warehouse.

Wrought-Steel Pipe: Black, 2½ to 6-in., lap welded, prevailing discounts from standard list, at warehouse, in less-than-carload lots.

Cast-Iron Pipe: Class B and heavier, size 6-in. and over, per net ton, in carload lots, f.o.b. city.

Portland Cement: Per bbl. of four bags, without charge for containers, in carload lots, f.o.b. city, or delivered to job, as noted in the table.

Gravel: Size ¾-in., per cu.yd., in carload lots, f.o.b. city. Weight per cu.yd.: New York, Atlanta, Dallas, Chicago, Montreal, 3,000 lb.; Seattle, 3,200 lb.; Minneapolis, San Francisco, 2,800 lb.; Denver, 2,700.

Sand: Per cu.yd., weighting 1½ tons (Seattle 2,800 lb.) in carload or cargo lots, f.o.b. city.

Crushed Stone: Size ¾-in., per cu.yd., in carload lots, f.o.b. city. Weight per cu.yd.: New York, Atlanta, Dallas, Chicago, Montreal, 2,500 lb.; San Francisco, 2,400 lb.; Minneapolis, 2,600 lb.; Denver, 2,700 lb.; Seattle, 3,000 lb.

Pine and Fir Lumber: Prices are for rough timbers, size 3 x 12-in. to 12 x 12-in., in 20 ft. lengths and under, per M. ft. b.m., in carload lots to contractors, f.o.b. city. Long-leaf yellow pine is quoted in certain of the cities and Douglas fir in the rest of those covered by the table, according to nearness to source of supply.

Lime: Hydrated, finishing lime, per ton, at warehouse, in carload lots.

Common lump lime, at warehouse, in carload lots, per small bbl. of 180-lb., net, or large, 280-lb., net, as noted in the table.

Common Brick: Price per M. in carload lots, f.o.b. city, or delivered to job, as noted in the table.

Hollow Tile: Building (load bearing) or partition tile, 4 x 12 x 12-in., per block, in carload lots, f.o.b. city, or delivered to job, as noted in the table.

Bids wanted Dec. 9 on viaduct of reinforced concrete and encased steel at Cincinnati, to cost $2,000,000, to be let by G. F. Schlessinger, state director of highways and public works, at Columbus, Ohio.